AMERICAN MACHINIST

October 1, 1941

Canada Contributes—*Industry north of the border shifts into high gear in filling Canadian and British war needs*

MASON BRITTON, Vice-Chairman
FRED H. COLVIN, Editor Emeritus
BURNHAM FINNEY, Editor
KENNETH H. CONDIT, Consulting Editor
JOHN HAYDOCK, Managing Editor

BEN C. BROSHEER — WILLIAM J. HARGEST
RUPERT LE GRAND, Detroit — C. G. SMITH, WILLIAM JESSUP
PAUL WOOTON, Washington — CHAS. F. McREYNOLDS, Los Angeles

N. O. WYNKOOP, Publisher
W. E. KENNEDY, Manager

McGraw-Hill Publishing Company, Inc.

Publication office, 99-129 North Broadway, Albany, N. Y. Editorial and executive offices, 330 West 42nd Street, New York, N. Y. Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta.

JAMES H. McGRAW
Founder and Honorary Chairman

JAMES H. McGRAW, Jr., President — HOWARD EHRLICH, Executive Vice-President
MASON BRITTON, Vice-Chairman — B. R. PUTNAM, Treasurer
D. C. McGRAW, Secretary — J. E. BLACKBURN, Jr., Director of Circulation

VOLUME 85 NUMBER 20

AMERICAN MACHINIST. Copyright 1941 by McGraw-Hill Publishing Co., Inc. Published every other Wednesday, price 35c a copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 West 42nd Street, New York, N. Y. Subscription rates — United States, Canada, Mexico and Central and South American countries $5.00 a year, $8.00 for two years, $10.00 for three years. All other countries $8.00 a year, $13.00 for two years, $16.00 for three years. Entered as second class matter, September 29, 1936, at Post Office, Albany, N. Y., under the act of March 3, 1879. Printed in U.S.A. Cable address: "McGrawhill, New York." Member of A.B.P. Member of A.B.C.

A McGRAW-HILL PUBLICATION

PRINTED IN U.S.A.

MAJOR ARTICLES

Care Makes Tools Live Longer.....*C. H. Borneman* 953
Shop Shots 956
Hardness and Quenching Mediums.....*J. G. Magrath* 958
Reduce Tire-Turning Costs.....*Lawrence W. Sagle* 961

ARMAMENT SECTION

Canada: Arsenal of the Empire..... 967
Steel Scrap to 25-Pounders..... 970
Shell Forging by the Upset Method..... 980
Producing Percussion Fuzes..... 986

SHORT ARTICLES

Many Hands..... 955
Procedure Bulletins? 963

IDEAS FROM PRACTICAL MEN

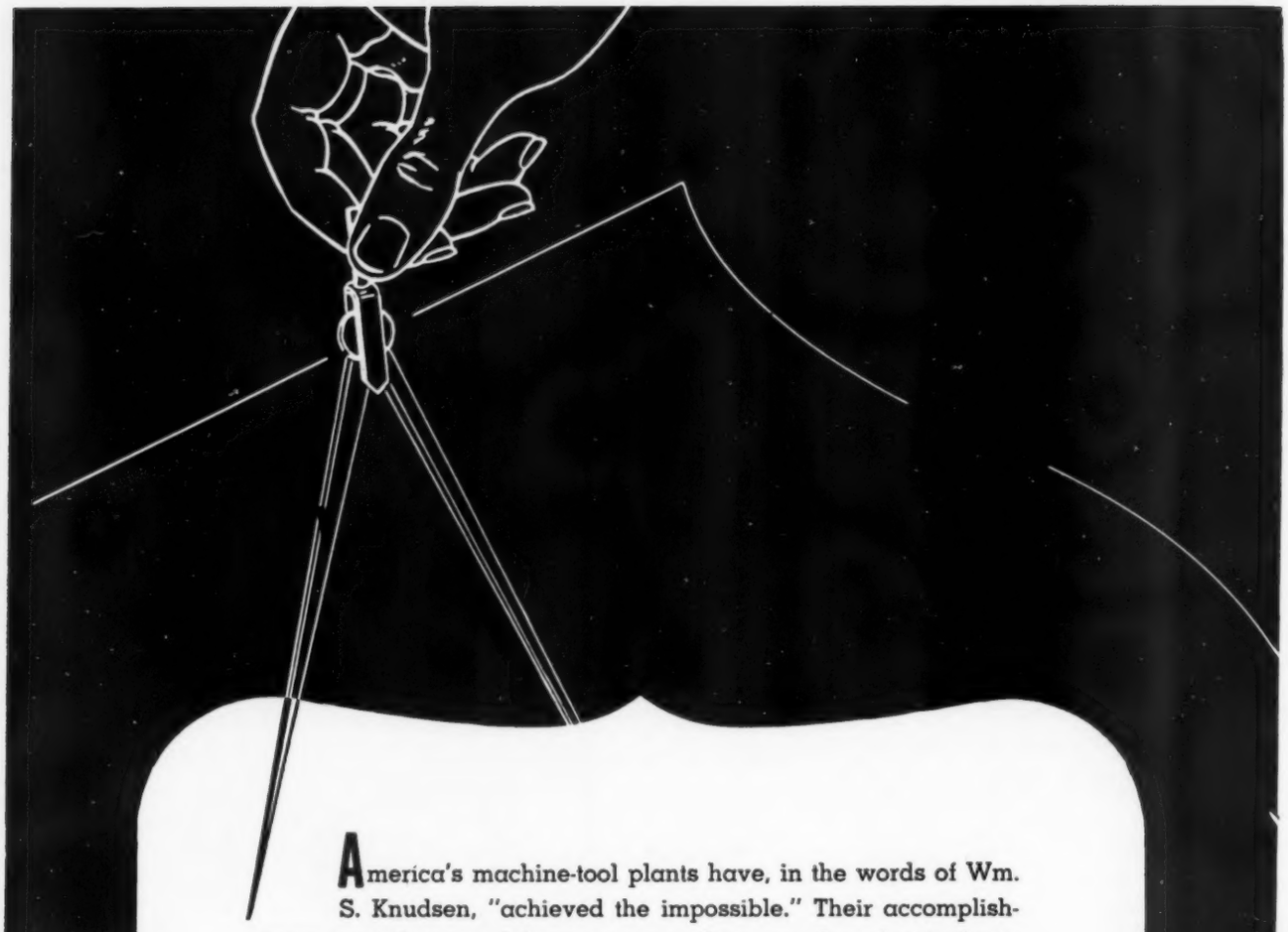
Embossing Shallow Shells Without Fractures....*S. Baldwin* 964
Boring Bar for Valve Seats.....*Martin H. Ball* 964
Splice Speeds Cable Applications.....*Arthur Havens* 965
Work Centered With Wiggler Pin.....*F. E. Clarke* 965
Shrinking Large Roller Races.....*Fred H. Colvin* 965
Flat on Boring Bar Reduces Chatter.....*Paul Grodzinski* 966
Fabricating a Bushing.....*A. H. Carroll* 966

NEWS OF THE INDUSTRY

Gaging Business..... 994b
Inside Detroit..... 994g
Watching Washington. 994i
Names in the News... 994k
Plant Expansion..... 994k
Obituaries 994l

DEPARTMENTS

Reference Book Sheet.. 991
Editorial 994a
Shop Equipment News. 995
Trade Publications.....1006
New Books.....1007
Seen and Heard.....1010



America's machine-tool plants have, in the words of Wm. S. Knudsen, "achieved the impossible." Their accomplishment is vital in our defense program, but more than that it charts a course for other metal-working plants faced with similar expansion problems. Therefore, American Machinist will publish, as its Nov. 26 issue

THE MACHINE TOOL PRODUCTION NUMBER

FEATURING

1. The Achievement of the Machine Tool Industry — a comprehensive study of the accomplishments of the industry in the defense program (Annual production $125,000,000 in 1938, $200,000,000 in 1939, $450,000,000 in 1940, $750,000,000 estimated in 1941.

2. How the Job was Done — Detailed studies of additions, new plants, sub-contracting, training, retooling and all the other expansion steps.

WHAT'S IN THIS ISSUE

C. H. BORNEMAN

REDUCE TOOL BREAKAGE

The national defense program has overtaxed manufacturers' capacity to produce metal cutting tools for prompt delivery. So today, more than ever before, shops must hold tool breakage to a minimum. This is no small task. Thousands of quickly trained men are operating machines which normally require skilled mechanics. To this potential source of tool breakage must be added new set-up men, new supervisors, new jobs, and increased output from each machine—the latter in itself, even with skilled operators, has increased the demand for new and replacement tools. C. H. Borneman, tool and gage supervisor, General Electric Company, Schenectady, N. Y., has surveyed this problem. On page 953 he tells how to reduce such breakage. Proper instruction for operators, correct handling, set-up and grinding of tools, and reclamation of broken tools are discussed.

REMOVE BEARINGS WITH CARE

The Reference Book Sheets, pages 991 and 993, give precautions for removing ball bearings while repairing machines. It is more difficult to remove a bearing from a shaft than to put it on. In many cases the damage is not visible and does not show up until the unit is reassembled—it is for this reason the listed precautions should be valuable to your maintenance men.

THOUSANDS OF FUZES A DAY

Fuzes for Canadian and British shell are made from a zinc-base alloy. The body, magazine and bottom cover are die cast, which shows a saving in material cost of over 50 per cent as compared to brass. Die casting the parts has reduced processing costs 33 per cent. Machine operations on these parts are illustrated by detailed tool set-ups. Also described are machines and fixtures for performing special operations. The story begins on page 986.

IMPROVES TIRE TURNING METHOD

The Baltimore & Ohio Railroad has found a way to hold tire-forming tools rigid in brake heads for machining tires within $\frac{1}{32}$ in. of being round while dragging the locomotive along a straight stretch of track. The method is used to restore tire contour when the locomotive is otherwise in good mechanical condition, thereby reducing expense involved in removing rods, binders and driving wheels to turn the tires in a lathe. Although the method has been tried before, the tires could never be turned true with the wheel center—the tools would follow the contour of the worn tire. Lawrence Sagle tells you on page 961 how the B. & O. overcame this difficulty. You may not know Larry, but when you see a movie with an 1832–1845 locomotive, he'll probably be the engineer. He's an authority on these old engines. Hollywood calls on him for technical advice and to handle the wood burners before the camera.

LAWRENCE W. SAGLE

THE PROPER QUENCH

The influence on flame hardening of percentages of alloying elements in cast, forged and rolled steel, as well as cast iron, has been explained by J. G. Magrath, Applied Engineering Division, Air Reduction Company in his series on oxyacetylene flame hardening. In the current installment (turn to page 958) he relates the importance of the nature, velocity and position of the quench. In addition, you'll find a comparison of athe hardnesses obtained with three quench mediums on steels of different compositions.

FROM THE EMPIRE'S ARSENAL

Field pieces for the British and Canadian armies are flowing in ever increasing quantities from a new factory at Sorel, Quebec. Steel scrap arrives by river barge and is made into 25-pounders. Steel mill, forging and machining operations on these field pieces are discussed in the Armament Section, page 970. The auto-frettaging method, which expands the barrels from 0.012 to 0.020 in. in the bore and from 0.006 to 0.010 in. on the outside, will be of special interest to U. S. ordnance manufacturers. The story exemplifies Canada's war effort—in less than two years this plant was planned, built and equipped, transforming a small French-Canadian town into a busy manufacturing center.

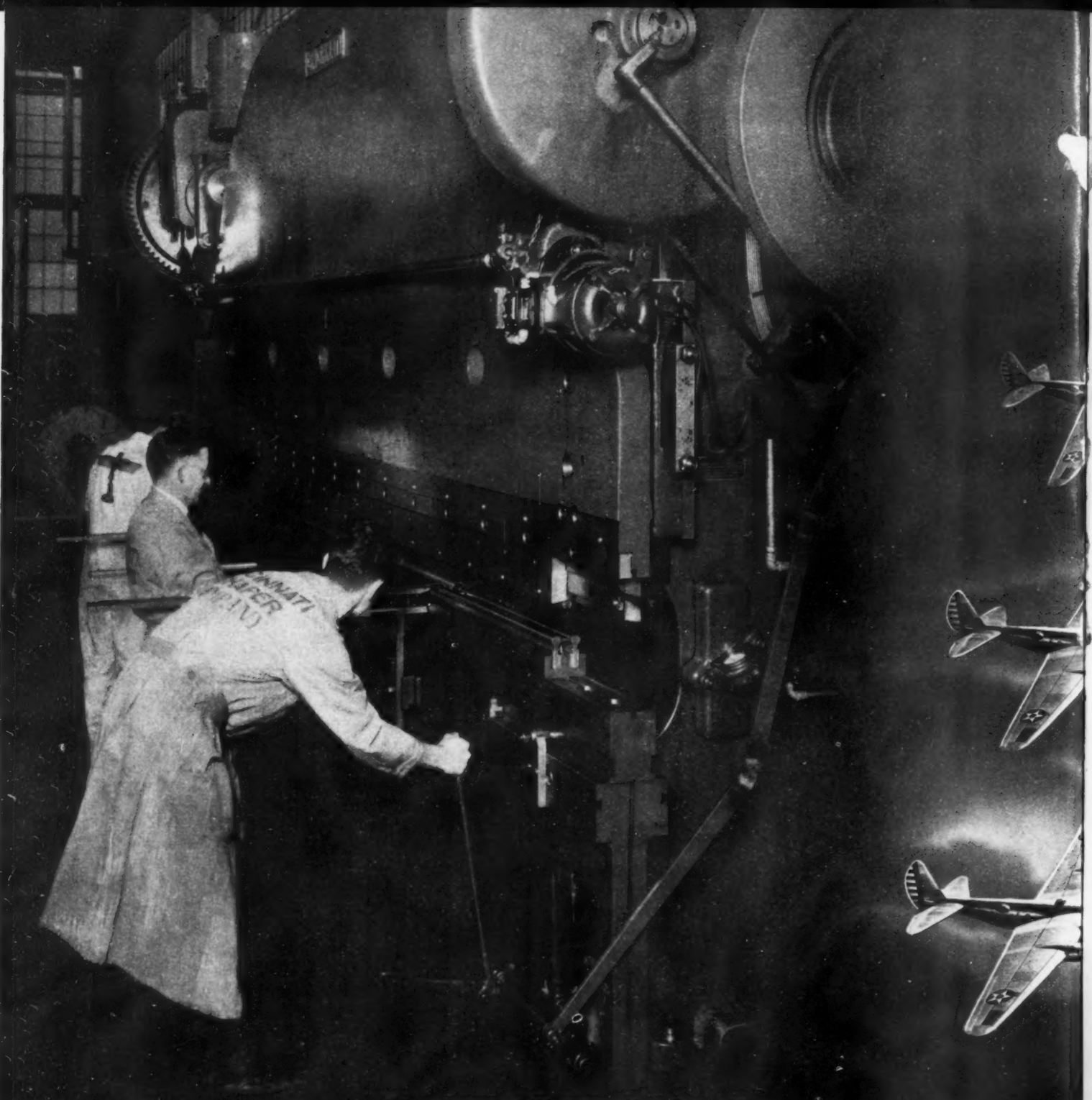
LESS MACHINING ON SHELL

One Canadian plant is using seven-impression dies in the upset method for forging 3.45-in. high explosive shell. The technique, described in the article beginning on page 980, lightens the machining load by chamfering the nose to reduce facing, by producing a short steep taper at the nose end of the cavity to reduce machining prior to nosing, and by tapering the tail to the approximate outside contour. Shell forging weighs 33 lb., and is machined to $20\frac{1}{4}$ lb. In this article you'll find a description of the forging method and equipment, analysis of punches and dies, and heat-treatment data.

COMING

Manufacturers of non-defense items will be interested in "The Working of Alternates for Priority Steels," a special "blue" section of the October 15 AMERICAN MACHINIST. There will be data on heat-treating, machining and applications of steels least restricted by government priorities.

Other features will be a preview of new equipment to be displayed at the National Metal Congress & Exposition in Philadelphia, a complete list of exhibitors, and general articles apropos of this meeting, including one on mechanized furnaces.



Cincinnati Press Brakes Form Sheets for Sky Ships . . .

The aircraft industry has used Cincinnati Press Brakes since airplanes were first built of metal. If you are an aircraft manufacturer or plan to sub-contract sheet metal work for airplane builders, write us for recommendations.

Cincinnati Press Brake illustrated is 14'-6" between housings; has 16'-8" overall die surface.

THE CINCINNATI SHAPER CO.

SHAPERS · SHEARS · BRAKES

CINCINNATI, OHIO.

ESTABLISHED 1877 **AMERICAN MACHINIST** BURNHAM FINNEY, Editor

Care Makes Tools Live Longer

C. H. BORNEMAN, SUPERVISOR, TOOL AND GAGE SERVICE, GENERAL ELECTRIC COMPANY

A tool used correctly will do the work of two or three tools improperly ground or misapplied

A TEAMSTER once said the main difference between horses and mules is that horses will work when they are tired out, and will strain themselves by attempting to pull loads beyond their strength whereas mules will quit when they are tired and will not strain themselves. In one way it's too bad that cutting tools are thoroughbreds; if they would only quit when they are dull, instead of continuing to cut, their production life would be doubled—or trebled.

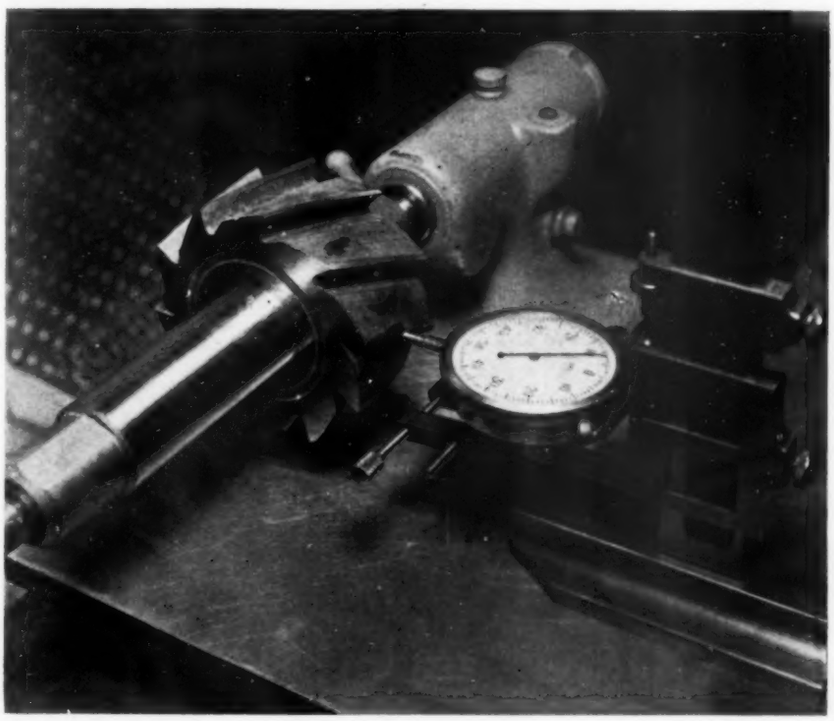
Tools Are At a Premium

The present emergency has resulted in a demand for cutting tools beyond industry's capacity to produce them promptly. To the ever-present demand for economy in the use of cutting tools there is added the more urgent demand for economy because procurement is difficult.

Tool breakage is the most paralyzing factor affecting machine output. New operators, new set-up men, new supervisors, new jobs, new night shifts all spell lack of experience and are potential sources of tool breakage. It can be reduced by double checking tool set-ups, by making careful trial operations to check for interference between tools and work-holding devices or machine elements, and by taking trial cuts at reduced feeds and speeds. Even then, crack-ups will happen.

The operator should be informed of the value of the machine and the tools he is to operate, and of the time required to obtain replacements—not to overawe him, but to help him appreciate the responsibility of his job. He should be encouraged to ask questions. Nervousness on his part should be interpreted as his desire to do a good job, and should bring forth reassurance from the foreman.

When a crack-up does occur, the operator, set-up man and supervisor should try to find the cause. Carelessness warrants reprimand, but the cost of a crack-up should not be aggravated by the discharge of a conscientious man who has made a mistake. He probably would not make that mistake again.

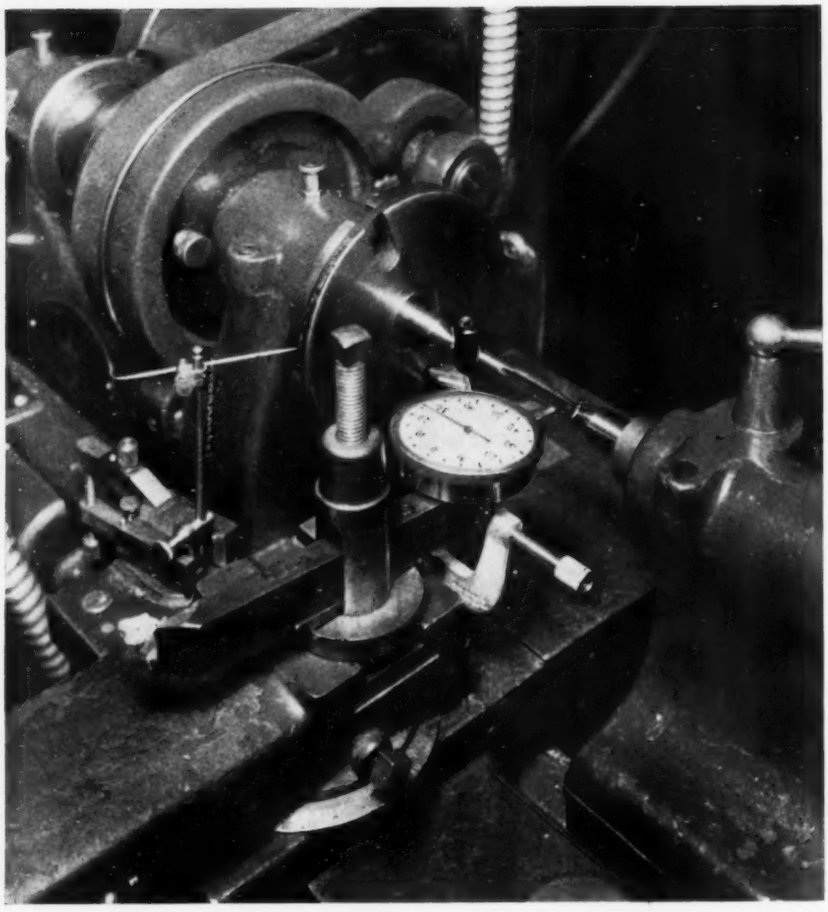


Cutter tooth runout can readily be detected by a dial indicator. If each tooth carries an equal load the cutter will last longer

Cutting tools are available as solid tools; composite tools of two materials welded together; tools with inserted bits, teeth, or blades; and tipped tools.

Solid tools include such types as milling cutters, small drills, chisels, files, stub reamers, taps, solid threading dies, rolled thread dies, broaches, and forged tools for lathes, and planers.

Composite tools, of two materials



An indicator with a small contact point will measure tap clearance. Too much clearance is a common fault that limits tool life

welded together, include taper-shank drills, reamers, shear blades, and tools for lathes, planers and other machines.

Under the heading of inserted tools are toolholders and toolbits, inserted-tooth milling cutters, inserted-blade reamers, die heads and chasers, boring bars, shell reamers, shell taps, broaches and inserted chaser taps, both collapsing and solid adjustable.

Grouped under the heading of tipped tools are toolbits, milling cutters (both solid and inserted tooth), boring bars with inserted bit, broaches, reamers (both solid and inserted blade), and tipped tools for lathes, planers and shapers.

How to Conserve Tools

To conserve cutting tool materials, inserted tools and tipped tools should be used wherever practical. Inserted-tooth milling cutters in sizes as small as 3 in. diameter are now available. Some methods for holding inserted teeth permit the close tooth spacing required for small inserted-tooth milling cutters.

Steel-cutting tipping materials also are available. They are not recommended for all steel-cutting operations, but the relatively small amount of cutting material they require in comparison with solid tools warrants their use on jobs where conditions such as speed, rigidity, and uninterrupted cuts are favorable for their use.

The possibility of obtaining satisfactory tools by salvage of existing tools should not be overlooked. Solid high-speed steel milling cutters offer particularly good salvage possibilities.

Not only can milling cutters be refluted, but some can be changed as to type. For example, a worn standard side milling cutter can be changed as to rake angle or can be changed to an alternate tooth or staggered side milling cutter. One tool-salvage company boasts of having salvaged a worn 8x1x1¼-in. side milling cutter successively to a 7½x⅞ in. and to a 7x¾ in. side milling cutter; then to a 6¾x0.630-in. spiral half-side mill, then to a 6x½ in., a 5½x⅜ in., and a 5x¼ in. stagger side mill; and finally to a 4½x0.192 in. special saw with side chip clearance.

Proper support of both cutting tool and work will conserve tools by increasing productive life. Minimum overhang, sturdy toolposts, and well-supported milling arbors are all important factors.

Proper alignment and location of tools with work will reduce wear and breakage. If holes are to be drilled and tapped on a radial drill, each hole should be tapped immediately after drilling; attempted relocating of the spindle for tapping will almost certainly result in mislocation which will unnecessarily wear the tap because of the tremendous side thrust imposed. The tap will also be forced to cut a greater depth of thread on one side of the hole than on the other. After a tap has produced the first few threads in a hole, any tendency of the machine or of the hole to change the direction of the tap exerts pressure against the flanks of the thread at opposite sides of the tap.

Proper Use Adds Life

Taps should not be overworked. For tough materials and deep holes, tap drill sizes should be increased above the normal size. When tap drill sizes appear to be unnecessarily small they should be called to the attention of the interested designer.

Reamers which are mislocated or misaligned with the holes likewise suffer unnecessary wear because of side thrust. Floating toolholders of the right type for the job will greatly increase reamer life. Those available include the angular float, parallel float and fixed-floating types. The last mentioned can be started as a fixed type and changed to floating during operation.

Only a half, a third—or even a smaller fraction—of the life of a cutting tool will be obtained if the proper coolant or lubricant is not used. What is the proper coolant or lubricant depends, of course, on many factors, including material, type of tool and cutting speed. Directions for their use are readily available, and they should be followed scrupulously by the machinist.

Cutting tools can be forced to remove metal after they have reached the point of dullness at which regrinding would be most economical. Of course they require more power to drive them. On continuous production jobs, careful attention to the determination of the most economical cutting life between grinds will usually result in the setting of a fixed number of parts to be produced between grinds. The quantity can, of course, be determined only after job standardization of all such elements as speed, feed, coolant, material to be cut, and type of tool. For instance, one of the twist drill manufacturers has set eight hours of production as the opti-

mum between grinds for milling cutters used in milling the flutes of high-speed twist drills on automatic machines.

Taps are probably the most abused of all the cutting tools. They are forced to remove metal when they need rechamfering—forced to do so since the lead of the thread and the chamfer establish the feed of the tap, and since the work confines the tool so it cannot spring away. A limited number of holes between resharpenings will add appreciably to tap life.

In resharpening cutting tools, the least possible amount of material should be removed from the cutting edges. Proper clearances should be established. Excess clearance will cause cutting edges to wear more rapidly than necessary, while insufficient clearance will mean the tool will not cut freely. For some operations clearance may be critical. For milling cutters a dial indicator with a small contact point will show exact clearance per $\frac{1}{32}$ in. or other increment of back-off when the cutter is rotated on centers.

Experience will bring out the proper clearances. These should be recorded where they will be available to the tool grinders, set-up men, planners, and supervisors. They should not be the private information of the tool grinders in the crib.

Inspection of resharpened tools is especially necessary in the case of milling cutters.

The tool grinder is an important factor affecting the conservation of cutting tools. If experienced men are not available, every effort should be made to train conscientious men for this work. Good lighting and adequate exhaust of dust-laden air are essential; cleanliness and good housekeeping will pay dividends.

Grind Tools Accurately

Proper grinding wheels must be used. Several grinding wheel manufacturers have published booklets, available for the asking, giving a wealth of information on tool grinding.

Finer finishes at cutting edges have been found to increase milling cutter life enough to make the finish grinding or lapping operation economical for some operations.

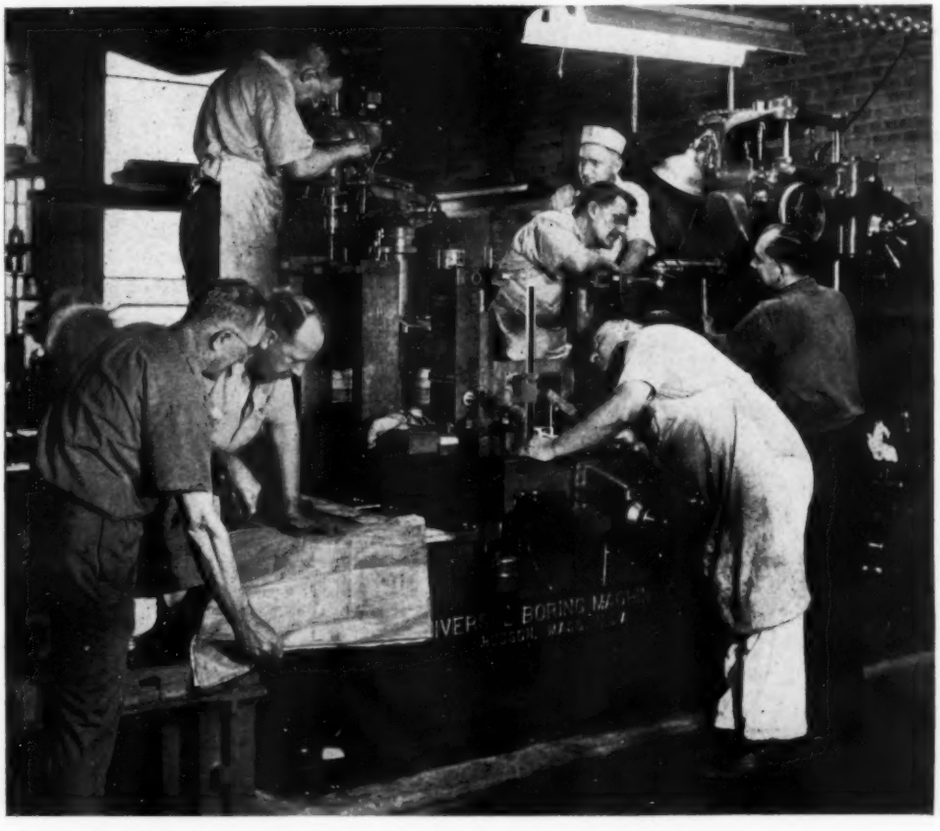
Proper chamfering of taps requires a good machine and a careful operator. Excess clearance is the usual fault. To check chamfer clearance accurately, a tap can be mounted with driving dog between centers in a lathe, and the lathe geared for the thread lead of the tap. An indicator mounted on the tool slide, with a small contact point or a knife edge contact point riding on the tap chamfer, will show the clearance in thousandths of an inch per $\frac{1}{32}$ in. or other increment of chamfer land.

Proper clearance can also be determined by rotating the tap in a close-fitting tapped hole. The indicator can be mounted on a surface gage so that the contact point will bear on the chamfer land.

After proper clearance has been determined by the lathe method or the nut method for a tap, the clearance for that tap, in a plane perpendicular to the axis, can be determined by rotating the tap freely between bench centers and noting the clearance of the chamfer land per $\frac{1}{32}$ in. or other increment as shown by the indicator. Greater clearance will, of course, be indicated in a plane perpendicular to the axis of the tap than along the helix.

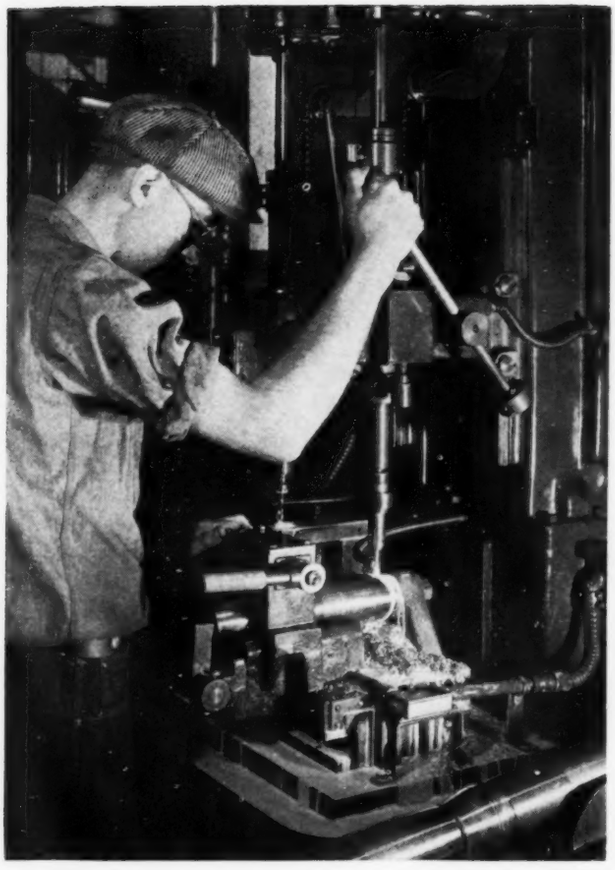
The setting of the tap chamfering machine should be recorded for each size and lead of tap so that this setting can be duplicated quickly at any time. Trials of different chamfer clearances in production tapping will establish the maximum clearance required, which will probably be surprisingly small.

We must conserve these small tools. This is especially true today when manufacturers are taxed to capacity to produce them for peak output from old machines as well as from thousands of new ones installed to meet the needs of our defense program.



Many Hands

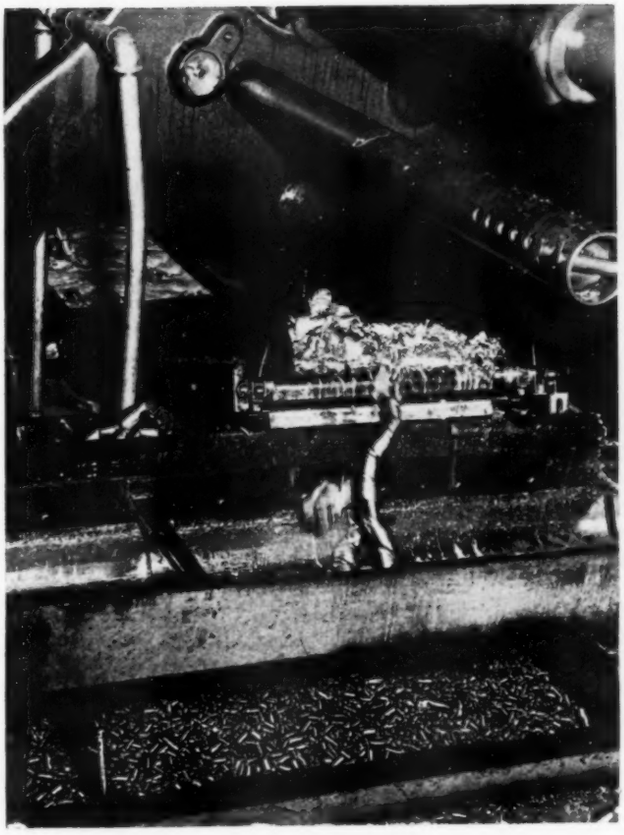
Only ten days were available to make a test fixture for the rear axle housing of the Chrysler tank, including pattern, casting and complete machining. To meet the schedule, the East Side Gear & Tool Company had to devise all possible short cuts. While the fixture was being bored on a Universal machine, a small radial drill was mounted on the table for drilling the small holes simultaneously. As soon as the operator had drilled a hole, another man came along and tapped it, while the drilling machine was working on the next one. The result was that there were four or five men working on the job at all times, some of whom were inspectors. The job was completed on time and needed no correction before shipping.



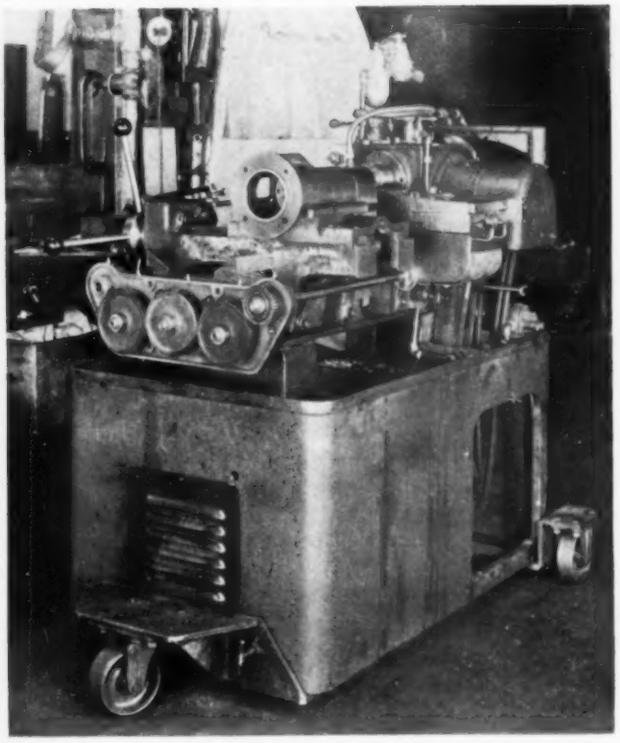
Shop Shots

Each 75-mm. high-explosive shell body is drilled and tapped near the nose end for a 0.3125-18 NC-2 lockscrew in an Avey two-spindle drill press. Fixture for this operation is slidably mounted on a special base on each end of which is a limit switch interconnected with the motor circuit for the spindle at that side of the machine. Thus, each spindle is rotated only when the fixture is accurately in position under it. The hole first is drilled at the left-spindle, with the drill guided by a rigidly supported, fixed-position bushing. Then the fixture is moved by hand to the right, and the hole is tapped. Quick-acting clamps hold the shell body in the fixture. Milwaukee Works, International Harvester Company.

Assembling a fine piece of machinery requires both care in keeping mating parts clean and skill in putting them together. In addition, there is the problem of eliminating unnecessary delays. Often special, welded-steel racks like those shown can be used to advantage in bringing sorted parts to subassembly groups. These racks are mounted on large casters, making it easy to move them between the stockroom and the assembly department. Those shown are designed to hold a predetermined number of parts of each unit going into a completed lathe apron. The stock clerk loads each truck with necessary parts, then the trucks are moved to a position just behind the workbenches. With all parts readily accessible, work can proceed with minimum delay. The Monarch Machine Tool Company.

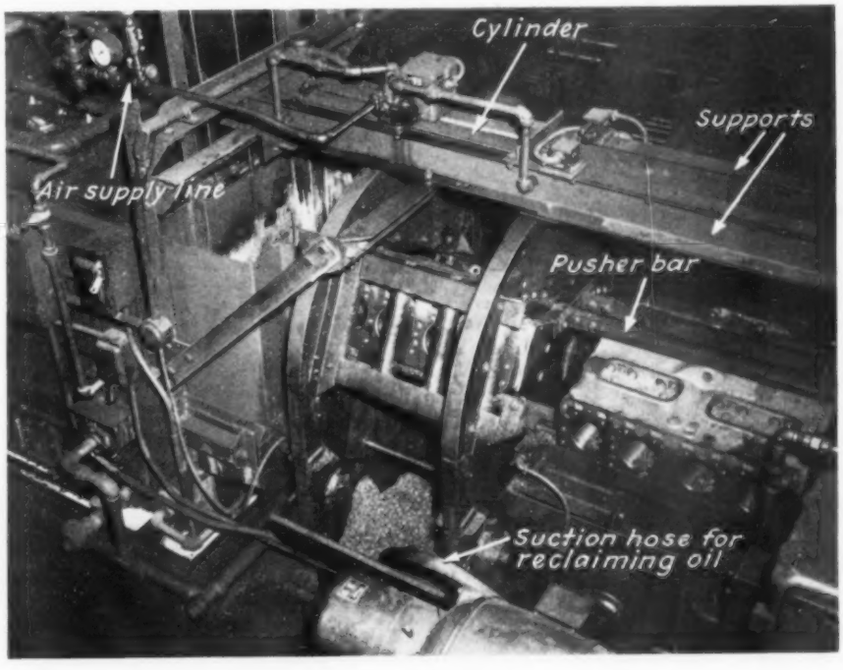


Chip disposal on screw machines used for fuze parts was a serious problem until conveyors were provided to move the chips from the individual machines to a chip crusher. Now a drag link conveyor in the bed of each machine moves chips from the coolant pan to a steel trough which runs the full length of the shop at right angles to the screw machines. An endless chain with steel scrapers moves chips along this trough to crushers. Steel chips then go by conveyor to freight cars and aluminum chips are delivered to a melting furnace. Stewart-Warner Corporation.



Simple welded steel dollies fitted with steel-wheel casters as shown serve to support the beds of Carbo-Matic and other lathes as they are moved from station to station down a progressive assembly line. It will be noted that the dolly at one end of the machine has only one caster, while the dolly at the other end has two fixed casters. This provides a three-point support for the assembly and prevents twisting the lathe bed and base as it is moved along the uneven assembly floor. Each set of dollies is arranged to take any one of several sizes of the standard line of machines built by the company. Each dolly is made from steel plate cut and bent to the required shape. Stiffeners are welded in place. W. C. Lipe, Incorporated.

A production line consisting of three automatic machines for drilling and tapping all of the holes in tractor engine crankcases was made completely automatic by using limit switch controlled auxiliary equipment for transferring the parts from one machine to another. The crankcases emerge from the first machine, being propelled by an hydraulically actuated pusher bar into the roll-over fixture. A limit switch is tripped to turn the roll-over 270 deg., causing the chips to fall into the pan below, and putting the crankcase into a vertical position. The pusher bar, actuated by the air cylinder shown at the top of the fixture, moves the crankcase into the washing machine at the left. The air cylinder, operated from the plant airline, and the pusher bar assembly are supported by the two structural channels which also carry the air valves and limit switches for the transfer units. International Harvester Company.



Hardness and Quenching Mediums

COMPILED BY J. G. MAGRATH, APPLIED ENGINEERING DEPARTMENT, AIR REDUCTION COMPANY

IN FLAME HARDENING the degree of hardness is directly dependent upon the analysis of the metal, carbon being the principal hardening element, and upon the rate of quench; the degree of heating above the critical temperature is of lesser importance.[4] When these variables are carefully regulated and coordinated uniformity in hardness is obtained.

All irons and steels that can be furnace hardened can be flame hardened. In general, higher hardnesses are obtainable on large objects by flame hardening than by furnace hardening, by the more rapid rate of cooling possible in the smaller heated mass and the self-quenching action of the part.

In general, the various analyses of iron and steel are flame hardenable to the degree shown in Table XI.

The theoretical relation between Brinell hardness and carbon content in carbon steel is shown in Fig. 13. It is based on a comparison of hardness acquired by small specimens as annealed and as water-quenched after furnace heating. In flame hardening, experience has shown that on steels below a carbon content of 0.40 percent, maximum hardness values obtainable may be as much as 50 points Brinell lower than those shown for nominal carbon analysis because of the commercial tolerances in carbon content and the sharp effect of carbon content on hardness in this range.[4] Thus a steel specified of 0.40 percent carbon which ordinarily should harden to 590 Brinell, may actually be only 0.35 percent carbon with maximum flame hardenability of 540 Brinell.

The lower curve in Fig. 13 indicates that the annealed steels gradually increase in hardness in direct proportion to increase in carbon content. The upper curve shows the maximum hardness obtainable in furnace-heating and water-quenching. These hardness values are obtained with fast cooling rates. Lower quenching rates will produce correspondingly lower hardness values. High degrees of hardness, 600 Brinell and over, are obtainable with medium carbon steels. In the unhardened state, they are machinable and may be readily fabricated. The top curve in Fig. 13 indicates the percentage increase in hardness of these steels as quenched over their hardness as annealed.

The six SAE carbon steels listed in Table IV, (*AM*—Vol. 85, page 699) are shown plotted according to their maximum Brinell hardnesses in Fig. 13. They compare favorably with the theoretical upper curve of furnace-heated and water-quenched carbon steels. This substantiates the use of this curve for indicating the maximum hardness values to be obtained with the flame-hardening process.

In flame hardening, an important part is played by the nature, velocity and position of the quench. A drastic quench, immediately following the heating flames, may raise the hardness to such degree that surface checking may develop. It is frequently advisable, when necessary to obtain a deep hardness by reducing the forward speed of flame application, to delay the quench by increasing the distance between the quenching zone and the heating zone. Too great an interval, however, may result in a drop in temperature below the critical, with the result that the quench is applied too late to produce hardness. Loss of hardness may also result by the drawing action of residual heat behind the quenching zone. This may be forestalled by the addition of a trailer quench several inches behind the hardening quench. The trailer quench should provide for the complete flooding of the object.

It is never advisable to harden an object beyond the degree required by the intended use, even though considerably higher hardnesses may be obtainable; the higher the hardness developed, the lower the shock resistance and the greater the tendency to check.[4] The maximum hardness is generally maintained over two-thirds the depth of the hardened case as indicated in a test shown on six steels as listed in Table XII and again as shown in Fig. 14.

Tables IV to IX inclusively (*AM*—Vol. 85, pages 699, 749, 806 and 849) show the maximum hardness obtained with various steels and irons. They are not offered as the necessary degree to which such metals should be flame hardened for specific applications. Actually, "hardness" is a general term used to describe an only partially understood property of materials. No one set of hardness values, now in use, can

Table XI—HARDNESS RANGE FOR STEEL AND CAST IRON

Classification	Carbon or Combined Carbon Content	Possible Brinell Hardness Range
Carbon Steels (Rolled, Cast or Forged)	0.35 C to 0.70% C	500 to 700
Low Alloy Steels (Rolled, Cast or Forged)	0.25% C and up	400 to 700
High Alloy Steels (Rolled, Cast or Forged)	0.30% C and up	425 to 700
Plain Cast Iron	0.50% C.C. and up	450 to 600
Alloy Cast Iron	0.40% C.C. and up	400 to 550
Malleable Iron	0.50% C.C. and up	400 to 550

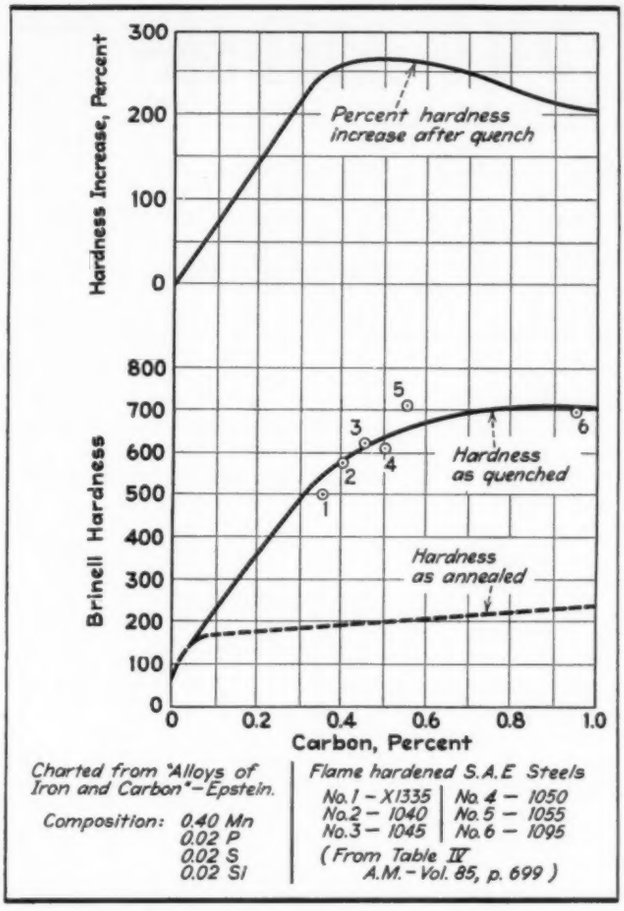


Fig. 13—The hardness of certain flame-hardened steels is graphically compared with furnace hardened specimens of varying carbon content. Hardness values shown by upper curve were obtained by rapid cooling

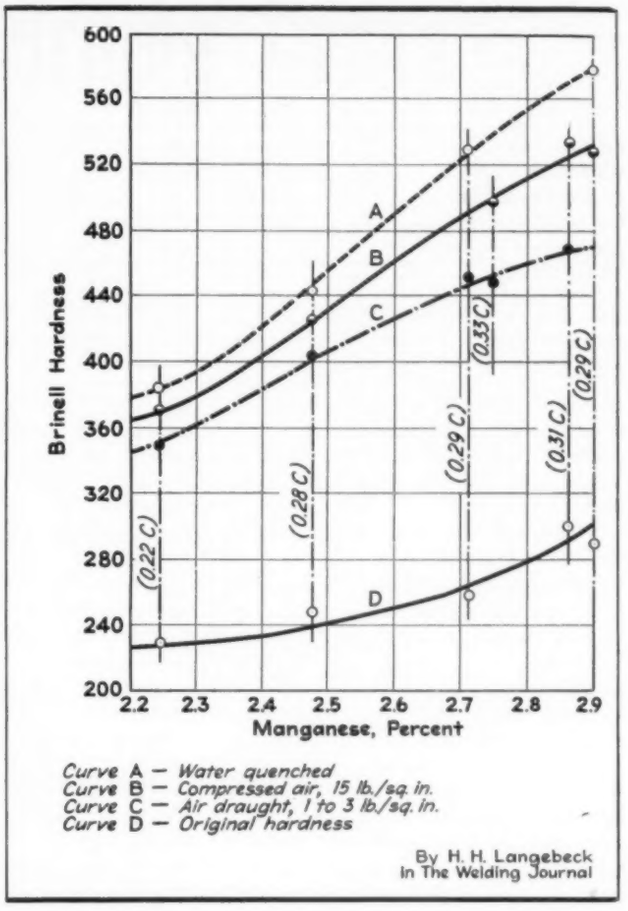


Fig. 15—Results obtained for different quenching mediums are compared on steels with rising manganese and carbon content but with constant contents of silicon, phosphorus and sulphur

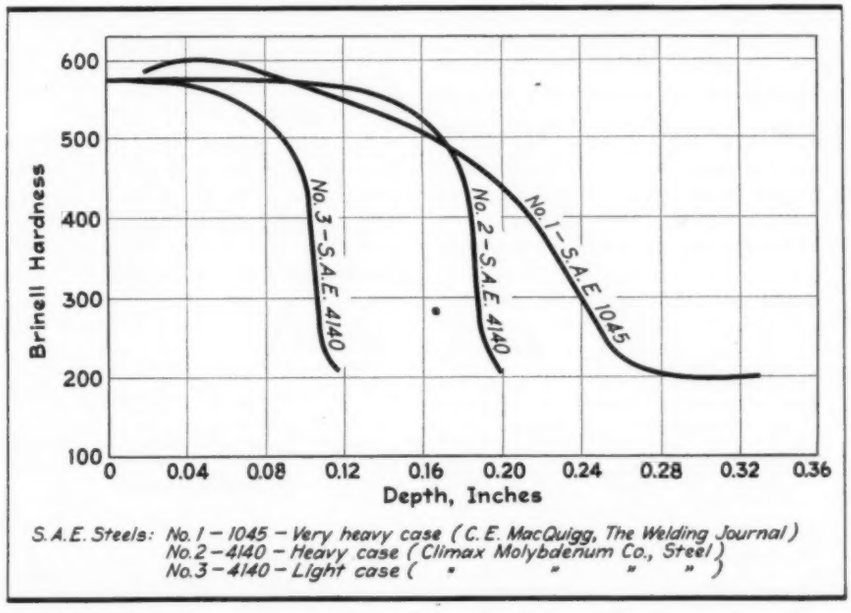

Brinell Hardness
No. 3 – S.A.E. 4140
No. 2 – S.A.E. 4140
No. 1 – S.A.E. 1045
Depth, Inches
S.A.E. Steels: No. 1 – 1045 – Very heavy case (C. E. MacQuigg, The Welding Journal)
No. 2 – 4140 – Heavy case (Climax Molybdenum Co., Steel)
No. 3 – 4140 – Light case (" " " ")

Fig. 14—Charted values of three steels of varying case depths indicate that the maximum hardness is generally maintained over two-thirds the total depth. Never harden an object beyond the degree required by the intended use, even though higher hardness is possible

be employed to compare accurately the relative resistance of any two materials under varying conditions of use. Failure of a surface may result from abrasion, spauling under impact, corrosion, lack of sufficient compression strength or lack of tensile strength at elevated temperatures, to mention a few of the physical properties involved.[4] Thus two steels of the same degree of hardness but differing in other physicals, may show different wear-resistance.

Principles of cooling that apply to other methods of heat-treating, apply in flame hardening. The faster the rate of cooling from above the critical temperature, the greater the degree of hardness.[11] The higher surface hardnesses frequently possible by flame hardening are a direct result of the steep temperature gradient between surface and base metal. The subsequent rapid flow of heat to the cold base beneath, in addition to the usual flow of heat to the externally applied quenching medium, results in faster quenching than is generally possible in furnace hardening.[11] Such extreme

Table XII—DEPTHS OF HARDENED STRUCTURES

	C	Mn	Ni	Cr	Mo	Vickers Hardness	Brinell Hardness	Total Depth	Martensite Depth	Troostite Depth
0.4 to 0.5 C	0.46	0.69				783	665	0.128	0.076	0.052
Chromium	0.42	0.71		1.05		782	663	0.108	0.084	0.024
Nickel-Chromium	0.39	0.56	1.52	1.16		770	638	0.108	0.080	0.028
Chrome-Molybdenum	0.36	0.60		1.13	0.31	726	606	0.108	0.096	0.012
3½ Percent Nickel	0.36	0.70	3.34	0.20		710	597	0.123	0.086	0.037
Ni-Cr-Mo	0.32	0.56	2.56	0.72	0.42	650	564	0.135	0.120	0.015

(Above from T. W. Lippert, *The Iron Age*, with Brinell Conversions Added)

quenching action is only obtainable in a surface heating and quenching procedure. In some cases it is possible to dispense entirely with pressure or bath quenches.

The quenching medium will vary in nature and temperature according to the analysis of the metal, the cooling rate and the hardness desired. The various procedure methods for flame hardening will allow the use of quenches as listed in Table XIII. In the progressive methods only non-inflammable quench mediums may be employed as the quench immediately follows the flames and functions within the flame zone. In spot hardening, unit area or band spinning methods where the flame is removed from the part before quenching, inflammable quenches can be used.[4]

The rate at which the metal cools will depend on the nature, volume, temperature and pressure of the quench. When water quenches are employed and the water is used both for cooling the flame-hardening tip and as a quench, it should be supplied in sufficient volume to prevent the formation of steam. If such formation is unpreventable and the cooling medium is unsuitable for quenching, then it should be diverted from the work and a separate quenching system installed. Generally, for best operation and results, the water quench should be no more than lukewarm. For mild quenches, hot water, soap solutions and soluble oils are frequently used, in addition to compressed air, or compressed air and water, at the lower pressures. More severe quenches are compressed air blast and cool water. The colder the water, the more severe the quench. Caustic and brine solutions have been employed as extremely severe quenches, but the opinion is general that no great advantage is gained by their use. Pressure quenches, necessary in the progressive methods, provide faster cooling than baths.

Many sensitive steels and cast irons which are not considered water quenchable in furnace methods of heat-treating can be safely water quenched when employing the flame-hardening process. Only a limited area is subjected to the spray quench so that the effect of contraction is small.[4] Further by controlling the position and volume of the quench, the quenching effect can be considerably milder than in an immersion quench. For example, 0.40 to 0.70 carbon steels are able to withstand drastic water quenches without great danger of checking or cracking. Steels of higher carbon content require special handling to prevent checking on a drastic water quench. It is often possible to arrange a water quench so that the temperature of the work is brought down to only 500 F. and then air cooled to room temperature.

When water quenches are employed and the water is supplied from municipal or industrial systems, sufficient pressure and volume to meet constant minimum requirements must be maintained. Careful, accurate pressure regulation is imperative and where the source of supply allows question as to available ample pressure or volume, boosters and reservoirs can be used.

Some of the higher alloy steels may be satisfactorily quenched with an air blast, such as the nickel-chromium, chrome-moly and chrome-vanadium with an 0.40 and 0.50 carbon content. These steels must be quenched carefully to insure against checking.

When heavier sections are being flame hardened, the unheated underlying metal assists external quenching and frequently permits the elimination of pressure or bath liquid or air-blast quenches. Still-air quenching is sufficient as in the case of SAE 4640 steel employed for gears which are to be flame hardened on the tooth faces, as illustrated in the photomicrographs in Fig. 4 (*AM*—Vol. 85, page 748). Frequently the greater mass of the part is cooled by either a water spray or bath while the area being treated is kept dry to be self-quenched in the still air and with the aid of the adjacent cold mass.

A comparison of the differences in hardness obtained with three different quench mediums on steels with constant contents of silicon, phosphorus and sulphur but with rising contents of manganese and carbon are shown in Fig. 15.[19]

Table XIII—QUENCHING MEDIUMS

Quench		Procedure			
Type	Medium	Spot or Unit Area	Progressive	Band Spinning	Progressive Spinning
Pressure	Water*	X	X	X	X
	Air	X	X	X	X
	Air and Water	X	X	X	X
Bath	Water	X		X	
	Soluble Oil	X		X	
	Oil and Water	X		X	

* Water — lukewarm, warm or hot, as required.

The next installment of this series will be found in an early number.

BIBLIOGRAPHY

4. Notes on Flame Hardening, by G. V. Slottman, July, 1940.

11. Flame Treating, by J. H. Zimmerman; *Heat Treating and Forging;* December, 1939.

19. Flame Hardening and Its Principles, H. H. Langebeck; *Welding Journal,* September, 1938.

Reduce Tire-Turning Costs

BY LAWRENCE W. SAGLE, THE BALTIMORE & OHIO RAILROAD

Here's a new method for holding and aligning tools when turning tires with wheels in place under a locomotive. Tire roundness is held to a tolerance of 1/32 in.

FLAT SPOTS on tires of locomotive driving wheels often develop when the locomotive is otherwise in good condition. A number of years ago the Baltimore & Ohio Railroad developed a method by which the contour of the tire tread and flange could be restored to I.C.C. standards while the wheels were in place under the engine with considerable saving in time and cost.

This was done by replacing the brake-shoe heads with holders for tire-turning tools which could be held against the wheels by the locomotive air-brake system, and then hauling the locomotive along a straight section of track. The object was to eliminate the maintenance expense involved in removing and applying main rods, side rods, binders, wheels, shoes, wedges, and driving wheel boxes not in need of repairs, and which must be stripped from the locomotive when the tires are turned in a lathe.

Old Method Discarded

The method did not produce consistently successful results, because the toolholders, mounted in the non-rigid brake beams, would permit the tools to follow the contour of the tires, making it difficult to maintain rotundity. But just recently the Baltimore & Ohio Railroad devised two ways for lining up the tools and holding them in positive position during the tire-turning operations. It is now possible to turn the tires perfectly round within a tolerance of $\frac{1}{32}$ in. without removing the wheels from the engine.

The aligning and holding device developed at the Cumberland, Md., shops of the B. & O. is shown in the drawing. As noted, means are provided for holding the brake beam immovable during the turning operation. On block-type pedestal binders, shown in Fig. 1, brackets *A* are held against the back of the binders by nuts on the pedestal bolts; the shape of the brackets depends on the horizontal distance between the back of the binders and the brake beam. Two typical shapes are illustrated at the two driving wheels shown in Fig. 1. The screw *B* is adjusted to proper length to maintain brake beam *C* and toolholder *D* in their proper position once the tool has been placed against the tire tread, but allowing of course sufficient movement of these parts to take the depth of cut required when brake pressure is applied. If necessary, Liners *E* can be placed between the bracket and the binder to align vertically the adjusting screw *B* and brake beam *C*. Also, yoke *F* can be used should the edge of the brake beam not be square.

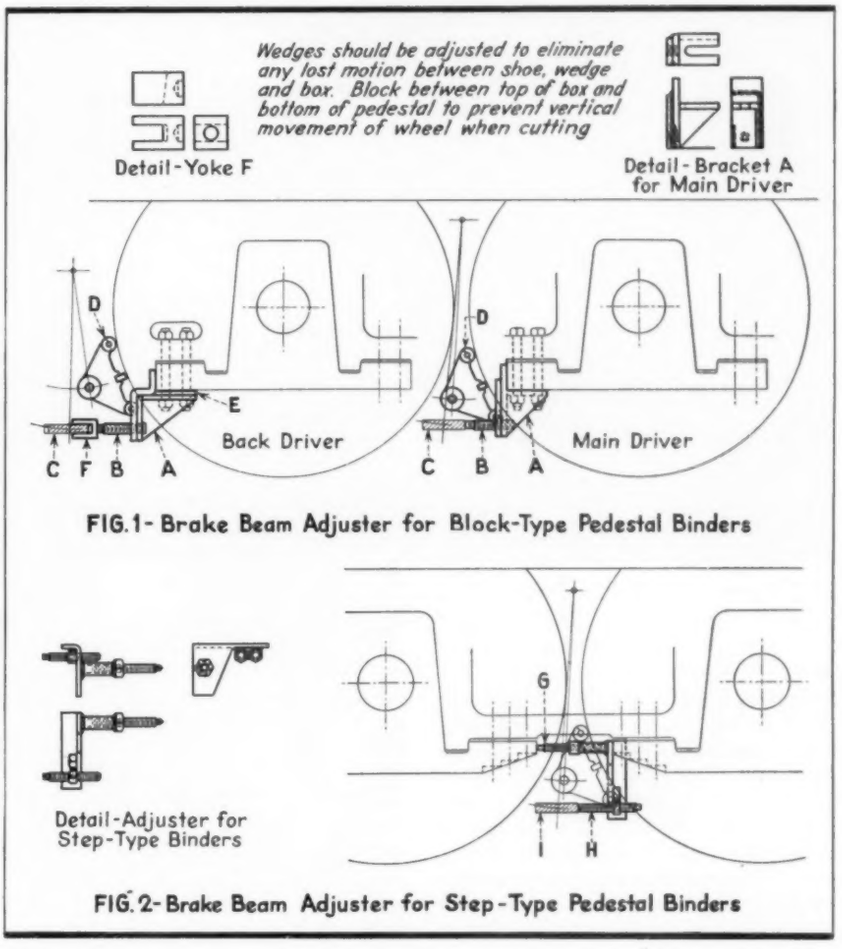

Wedges should be adjusted to eliminate any lost motion between shoe, wedge and box. Block between top of box and bottom of pedestal to prevent vertical movement of wheel when cutting
Detail-Yoke F
Detail-Bracket A for Main Driver
D
E
Back Driver
C F B A
D
Main Driver
C B A
Detail-Adjuster for Step-Type Binders
G
I H

FIG. 1- Brake Beam Adjuster for Block-Type Pedestal Binders

FIG. 2- Brake Beam Adjuster for Step-Type Pedestal Binders

When turning the tread and flange of locomotive tires with the wheels in place, the brake beam and toolholder must be maintained at a definite distance from the wheel center. This can be done with brackets clamped to the pedestals, and adjusting screws set against the brake beams

The adjusting device for step-type of pedestal binders is shown in Fig. 2. The adjusting screw *G* is placed between the step binders of adjacent wheels, and the adjusting screw *H* is used to locate the brake beam *I*.

The second method devised by the Baltimore & Ohio Railroad for maintaining the adjustment of the brake beam was developed at the Ivorydale, Md., shops. The brake beam is located positively by a pair of bracket arms fastened to the axle with a roller clamp, and at the other end by a screw adjustment to the brake beam, similar to the

A Lidgerwood towing device clamped to the rails hauls the locomotive down a straight track. Air pressure applied to the brake system holds the form tools against the tires

arrangements shown in the accompanying drawing.

In both devices, the screw adjustment maintains accurately the location of the brake beam in respect to the wheel center. This enables the cutters to machine off the high spots of the tires first, and reach a true contour similar to the operation on a large wheel lathe.

Towing Device Supplies Power

During the tire-turning operation, an electrically operated Lidgerwood towing device is placed at one end of a straight track not less than 240 ft. long, and securely fastened to the rails to prevent its moving. A small tool car is coupled to the locomotive. The cable from the Lidgerwood power drum passes around a sheave of the tool car, then back through a sheave attached to the Lidgerwood coupler, and finally back to the tool car where it is anchored. Sufficient power is thus provided to drag the locomotive along the 240-ft. track during the tire-turning operation. When not in use, the tool car is used for storing the various cutter heads, sheave wheels, tools and gages required for the job.

If the brake shoes are in front of the driving wheels, the front of the locomotive must be toward the Lidgerwood, while the rear end of the locomotive must be toward the towing device if the brake shoes are in back of the wheel. The locomotive must be under a sufficient head of steam to enable it to move under its own power. Then the brake heads are removed and toolholders similar in shape to a brake head but with rollers at the top and bottom to minimize friction are applied. The cutting tools are placed in the holders after the latter have been mounted on the brake hangers adjacent to each wheel.

The tire-turning form tools are 18-4-1 high-speed tool steel, and are similar to the types used on standard wheel lathes. Each is inserted in the tool-holder and aligned with suitable fillers until the tool comes into contact with the tire. The C-6 reducing or feed valve on the locomotive is then set for 15 lb. per sq.in. after which the air is applied, forcing the tool against the wheel. The locomotive is then pulled backward or foreward, as desired, in the direction of the cut to be taken, at a speed depending on the thickness of the cut and the diameter of the driving wheels. This speed will vary from 5 to 10 ft. per min. by the Lidgerwood. When the locomotive comes to a stop, the tools are released from contact with the wheel by releasing the air pressure, and the locomotive is run to the opposite end of the track. The operation is repeated often enough to obtain a true contour in accordance with standard driving wheel tire gages.

Before the tires are turned, the machinist must find the true center of the wheel, and with a tram scribes arcs at four places on the tire, which gives a check on the true roundness of the tire. Also, the arcs are used for setting a depth gage to locate low spots around the wheel.

When to Use the Method

Where one set of driving wheel tires is worn far in excess of others, which is often the case with regard to the front wheels, it would not be economical to turn down all of the tires to conform with the wear of the one pair. In cases like this, the excessively worn pair is removed, via the drop pit, and a set of tires that nearly match the others on the locomotive are applied. The pair of wheels is then replaced on the locomotive and the entire set is turned down with the Lidgerwood device. It must be remembered that it is only economical to turn down tires

The Lidgerwood towing car has an electrically operated winch for winding the cable that passes to the towing car on the locomotive, then through a sheave wheel on the stationary Lidgerwood, and back to the locomotive

After the machinist locates the true center of the wheel, he scribes four arcs at four places on the tire. The arcs are used to locate low spots and to ascertain the roundness of the tire after it has been machined

The machinist uses this special gage to locate low spots on the tires. Once these have been determined, the brake beam with toolholder attached can be set properly for making the cut

with the Lidgerwood if all parts of the locomotive, such as crown bearings, driving boxes, shoes and wedges, side rods and main rods are in good shape. If the locomotive must be shopped for other repairs, then the wheels are removed and the tires turned in large wheel lathes in the shop in the usual manner.

Use of the Lidgerwood device has unquestionably reduced maintenance costs. Where the foundation of the locomotive is otherwise in good condition, tires with high flanges, burred rims and flat spots may be turned round within a tolerance of $\frac{1}{32}$-in., thus saving the expense of placing the locomotive on a drop pit or taking it to the back shop for removal and reapplication of the wheels.

Procedure Bulletins?

The question arises, "Should the War and Navy Departments release procedure bulletins for munitions manufacture to responsible suppliers of equipment?" Currently, two or more vendors may approach a munitions contractor with equipment proposals based upon widely divergent views of the proper process control of the material under discussion.

For example, heat-treating equipment and cycles. One supplier may suggest from knowledge of two or three somewhat similar jobs that the soaking period should be two-thirds the time during which work is in the furnace. His competitor asserts that the soaking period should be only ten per cent. Each speaks from limited knowledge of the exact metallurgical control deemed necessary by the War or Navy Departments to secure acceptable material. The contractor is in the middle, and often technically unable to make a proper decision of an involved metallurgical problem on which he has had no previous experience.

Under these circumstances, would it not be better to give a numbered copy of the proper specification or procedure bulletin into the hands of vendors requiring them, upon the understanding that only responsible company executives would have access to the data? Then there might well be fewer misunderstandings and perhaps costly delays.

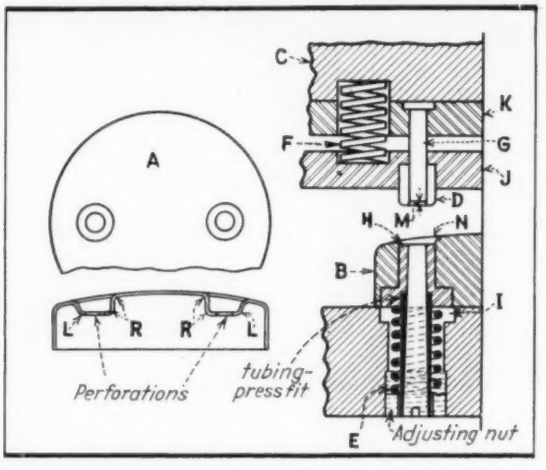
This example is based upon an actual occurrence in one specific industry, but doubtless there are others where vendors might benefit by knowing what qualities the government is looking for in specified types of material and what each process must accomplish.

IDEAS FROM PRACTICAL MEN

Embossing Shallow Shells Without Fractures

BY S. BALDWIN

We recently had to emboss and perforate a large quantity of shallow shells as shown at *A* in the drawing. The shell had been drawn previously in another operation, and for the embossing it was inverted and placed over the embossing die *B*. When the punch assembly *C* descends, the bushings *D* starts forming the depressions and continues downward compressing the springs *E* until their pressure equals that of springs *F*. As the punch members continue downward, both sets of springs are compressed, causing the piercing punches *G* to extend below the bushings *D* and pass through the bottom of the partly formed depressions and enter the piercing dies *H*. The punch member continues downward until the die *H* reaches the bottom of recess *I*, and the spring pad *J* seats on the punch pad *K*, thus completing the operation.



The depressions in this shell had to be embossed and perforated after the shell had been drawn. After the embossing is started, the hole is pierced and the embossing completed. This eliminated fracturing the shell

The material from which these shells are made is punch-temper cold-rolled steel 0.050 in. thick. Rather than draw and pierce the shell in one operation, we found it advisable to separate the operations in order to minimize fracture during the embossing and piercing. This would result because the depressions are so close the edge of the shell, and the amount of metal which can be drawn from around the depressions is practically none. In the operation as described, that is, embossing and piercing as a separate operation, the required depth is obtained by stretching the metal and by drawing it from around an initial perforation which is automatically enlarged by that process.

The size of the initial piercer to perform this latter function was determined by trial. In addition to the size of the piercer, the successful forming of the depression depended mainly upon the earlier or later point in the operation that the piercer actually passed through the metal, since if too early the perforation would stretch too large and if too late it would be too small, and besides the metal would be liable to fracture at point *L*, owing to the excessive stretch of the metal before being relieved by piercing. In addition, radii *R* must be as large as permissible to prevent fracture or undesirable strain.

The factors which control the timing of the actual preliminary piercing are the resistance of spring *E*, the amount that the face of the piercer is set back of the forming punch or bushing as at *M*, and the degree of sharpness maintained on the cutting edge of the piercer.

To avoid the expense of a re-pierce operation, a tolerance of plus or minus 0.010 in. was allowed on the size of the perforation. Because of this, the edge of the perforation was naturally distorted slightly from a perfect circle. Also it had some burrs because of the excess punch-and-die clearance which had to be allowed on the die bushing at *N* to avoid the necessity of sharpening, which would require subsequent adjustment for depth.

This tool as described operates on the principle of opposed springs, which is not usually good practice. But in this case trouble is avoided by giving the upper springs plenty of length and strength, and by making the pressure of the lower springs adjustable either as shown or by the use of underslug springs.

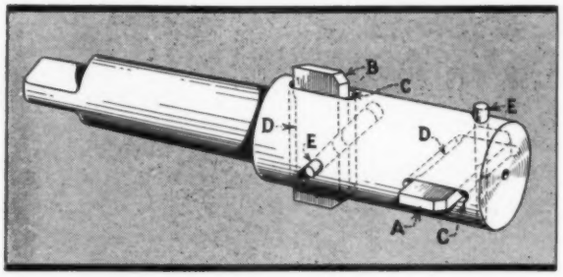
Boring Bar for Valve Seats

BY MARTIN H. BALL

The boring bar shown in the drawing was designed to bore a 3-in. pilot hole with cutter *A* and face a $3\frac{9}{16}$-in. diameter valve seat in a manifold casing with cutter *B*. The slots *C* through the bar were made with rounded ends to simplify their machining, and the cutters were relieved at the center *D* on the side taking the thrust, leaving only about $\frac{1}{4}$ in. bearing at each end of the slot in the bar. They were locked in place with a standard taper pin *E* having a half bearing on the cutter. This bearing for the taper pin, together with the relieved back of the cutter, forms a three-point locking and non-rocking support.

The taper pins are of high-carbon steel, hardened and drawn to a spring temper. The cutters are of

high-speed steel, hardened on their ends only so that when they become worn they may be peened and stretched back of the hardened portion, thereby lengthening them for regrinding to the original size. The



The cutters in this boring bar are relieved at the center of the end taking the thrust. They have three-point bearing for non-rocking support

final sizing of the cutters is done when assembled in the bar.

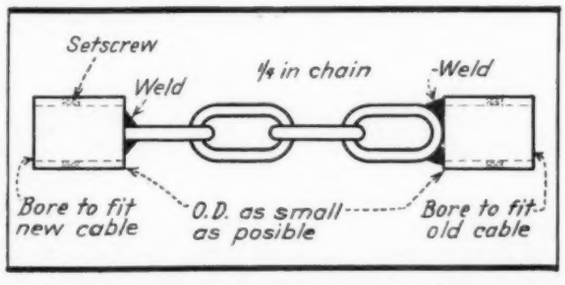
This method of locking the cutters with a taper pin, insures centralizing the cutters in the bar at all times.

Temporary Splice Speeds Cable Applications

BY ARTHUR HAVENS

Climbing to some obscure and difficult place to guide a cable through a sheave is often more work than the whole job of replacing the worn cable. A mechanic faced with this problem built the illustrated device that enabled him to fasten the new cable to the one about to be removed, and use the old cable to guide the new one through the sheaves and pulleys at the top of a coal chute.

This temporary splice was made from two steel bushings bored to fit the 1-in. cable. The outside diameter of the bushings was turned as small as possible and still leave enough stock to hold a few threads of $\frac{3}{8}$-in. hollow-head setscrews. Four links of $\frac{1}{4}$-in. chain were welded to the bushings. The cable was unhooked from the coal bucket and one end of the temporary splice fastened to the old cable. The other end of the splice was fastened to the new cable. The machine was started and the old cable run through several sheaves and pulleys, drawing the new cable behind it.



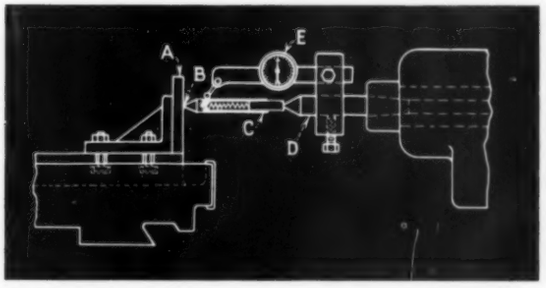
This temporary splice between old and new cable eliminates climbing to inaccessible places to guide the new cable through sheave wheels

Work Centered With Indicator and Wiggler Pin

BY F. E. CLARKE

In drilling and boring close work on a milling machine, jig borer, horizontal boring mill or drill press, it is sometimes desirable to set the machine spindle accurately in line with a prick punch in the work that has been laid out in the conventional manner. This can be done without guess work in the following manner:

Referring to the drawing, *A* represents the work with the prick punch mark at *B*. The wiggler pin *C* is pointed at one end to enter the prick punch mark, and has a spring plunger in the other end. This spring plunger has a center hole drilled in its outer end to locate on the center *D* in the machine spindle. Dial indicator *E* should be clamped rigidly to the machine spindle in any convenient way and contacting the wiggler pin as near the work as possible. Now



The machine spindle can be centered accurately with a prick punch mark in the work by a wiggler pin and dial indicator

by revolving the indicator and wiggler pin with the machine spindle, any error in the setting will be shown by the movement of the indicator pointer. The work can then be adjusted until the indicator reads the same at all points in a revolution of the spindle. Then we are sure of a correct setting.

Shrinking Large Roller Races in Place

BY FRED H. COLVIN

Sometime ago I saw an interesting job of shrinking roller races for Timken bearings in place on locomotive driving wheels. This was at the Roanoke shops of the Norfolk & Western Railway. Here the inner roller races were being heated by immersion in boiling water to expand them sufficiently to go over the axle sleeve and grip it on cooling.

The other day I saw this in reverse in the shop of a well-known builder of machine tools, where roller races of perhaps 20 in. in diameter are expanded into the headstocks by the freezing process. The method was different than I had seen and seems to have much to recommend it.

A well-insulated box is divided into rectangular compartments on the bottom. These compartments serve two functions: They support the roller race and

provide space for the dry ice so that it does not come in contact with the work.

The box is filled with alcohol to a depth that will cover the roller race as it lies on the top of the partitions. Sufficient dry ice is put in to cool the alcohol to about 40 deg. below zero, which gives all the contraction needed to slip the roller race into place before it assumes room temperature. This temperature has been found sufficient to produce race tightness for every service requirement.

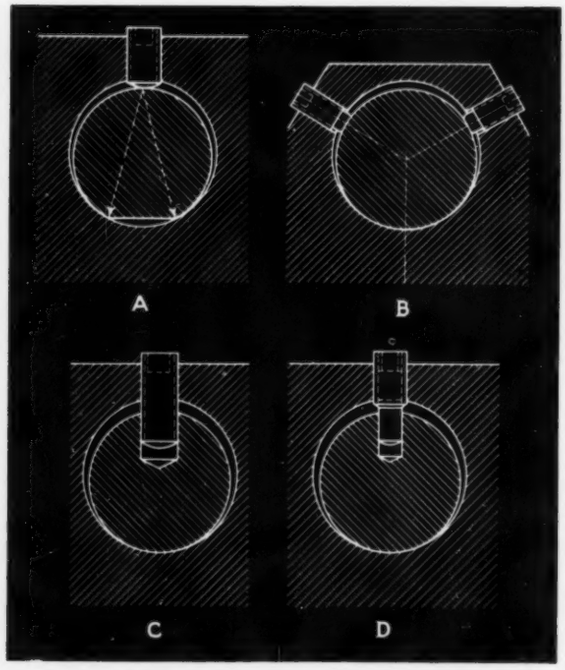
This method also has the added advantage of avoiding any "frosting" of the work. This frosting or "icing" becomes very troublesome in some cases and interferes with the insertion of the work into place. It is being used very successfully in this plant and can readily be adopted to almost any work where a part must be shrunk prior to assembly.

Flat Ground on Boring Bar Reduces Chatter

BY PAUL GRODZINSKI

The flattening of a boring bar shank opposite the clamping screw as shown at *A* in the drawing has been suggested (*AM*—Vol. 85, page 226) as a means to secure three-point bearing beneath the clamp and thereby reduce chatter. Such flattening might have provided an easy cure in the case cited, but it is not generally to be recommended. It tends to bring the bar and attaching parts considerably out of center. Therefore, it seems to be better to apply two clamping screws at an angle of 120 deg., as shown at *B* in the drawing, which arrangement is used frequently. In some cases this is not possible, for instance if the space is restricted and only one screw is more or less accessible.

The writer experienced such a case in a crank linkage, which showed a considerable backlash owing to the fact that the bar could rock on the screw center point. In this case, the female screw thread was extended into the bar, and a longer binding screw used, as shown at *C*. In this latter arrangement, the screw is stressed in shear. To avoid such stress, the screw end could be provided with a small cylindrical shank fitting in a hole in the bar as shown at *D*; in this case, the shank would prevent the bar from rocking, while the beveled edge of the screw would provide the necessary clamping force.



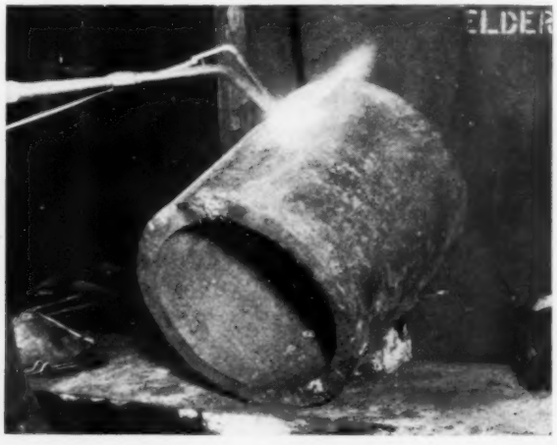
Instead of flattening the boring bar opposite the setscrew to prevent chatter, which will throw the bar out of line, either one of the three alternate methods is recommended

Fabricating a Bushing

BY A. H. CARROLL

When a heavy steel tub is needed for bushing material, or any of the myriad requirements of heavy steel tubing, and no material of the type needed is available, a substitute can be made from flat stock of the proper thickness.

A piece of flat steel thick enough to turn and bore to the desired finished size is heated and rolled to the required diameter. This tube is then taken to the welder who will scarf the edges of the seam and either acetylene or electric weld it into a solid cylinder.

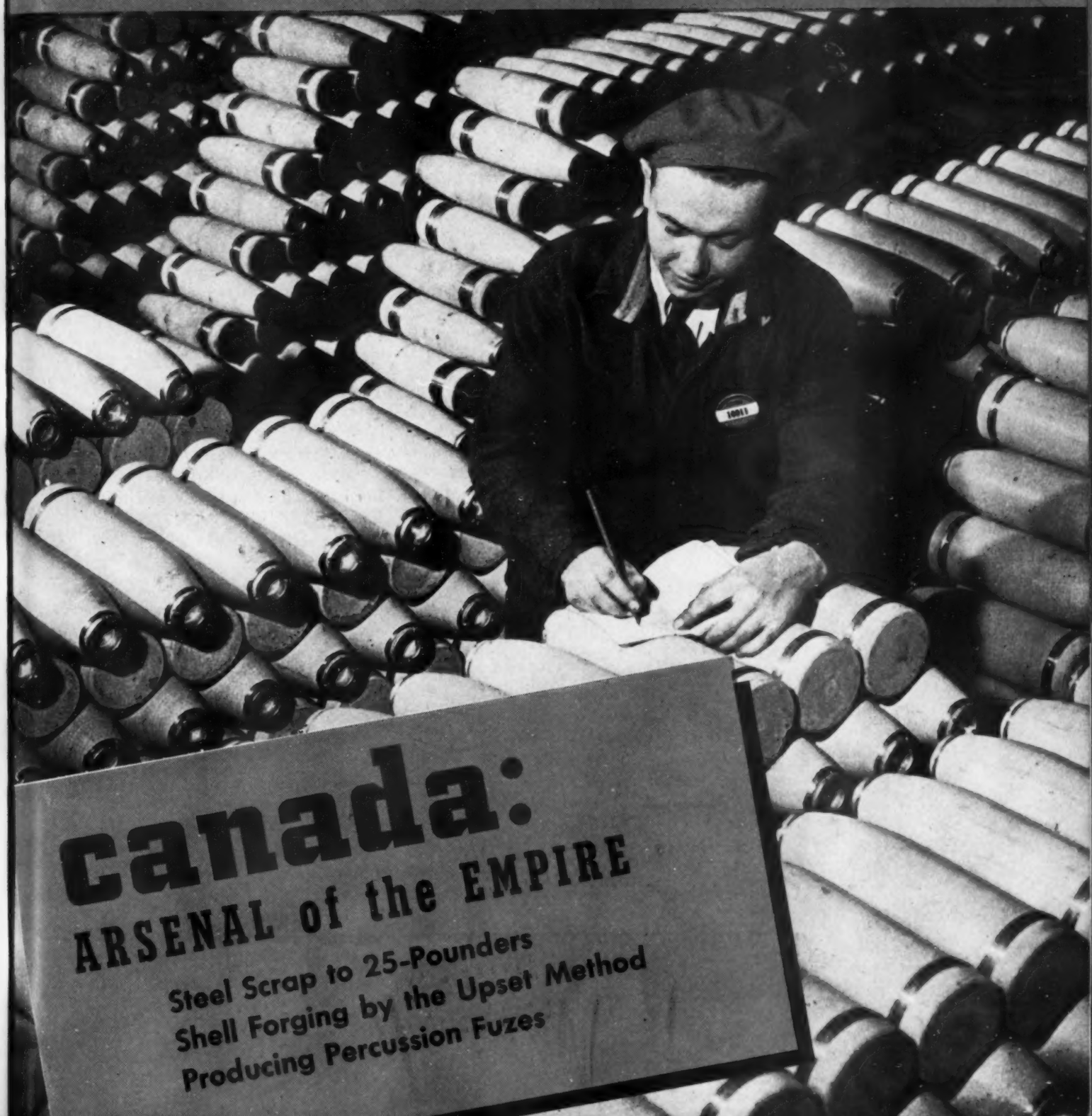


Odd-size steel bushings or tubing can be made by rolling flat stock to the required diameter, welding the seam and machining it to finished size

The illustration shows a welder making a steel bushing to be used as a repair on a cast-iron hydraulic press. The bushing when completed was shrunk on the cracked cylinder of the press. Such bushings can also be used for blocking on locomotive wheel and rod presses, in which case it is only necessary to turn the ends parallel to each other and grind the weld flush with the body of the cylinder. Similar bushings, but made in smaller sizes, can be used for king pins in engine trucks.

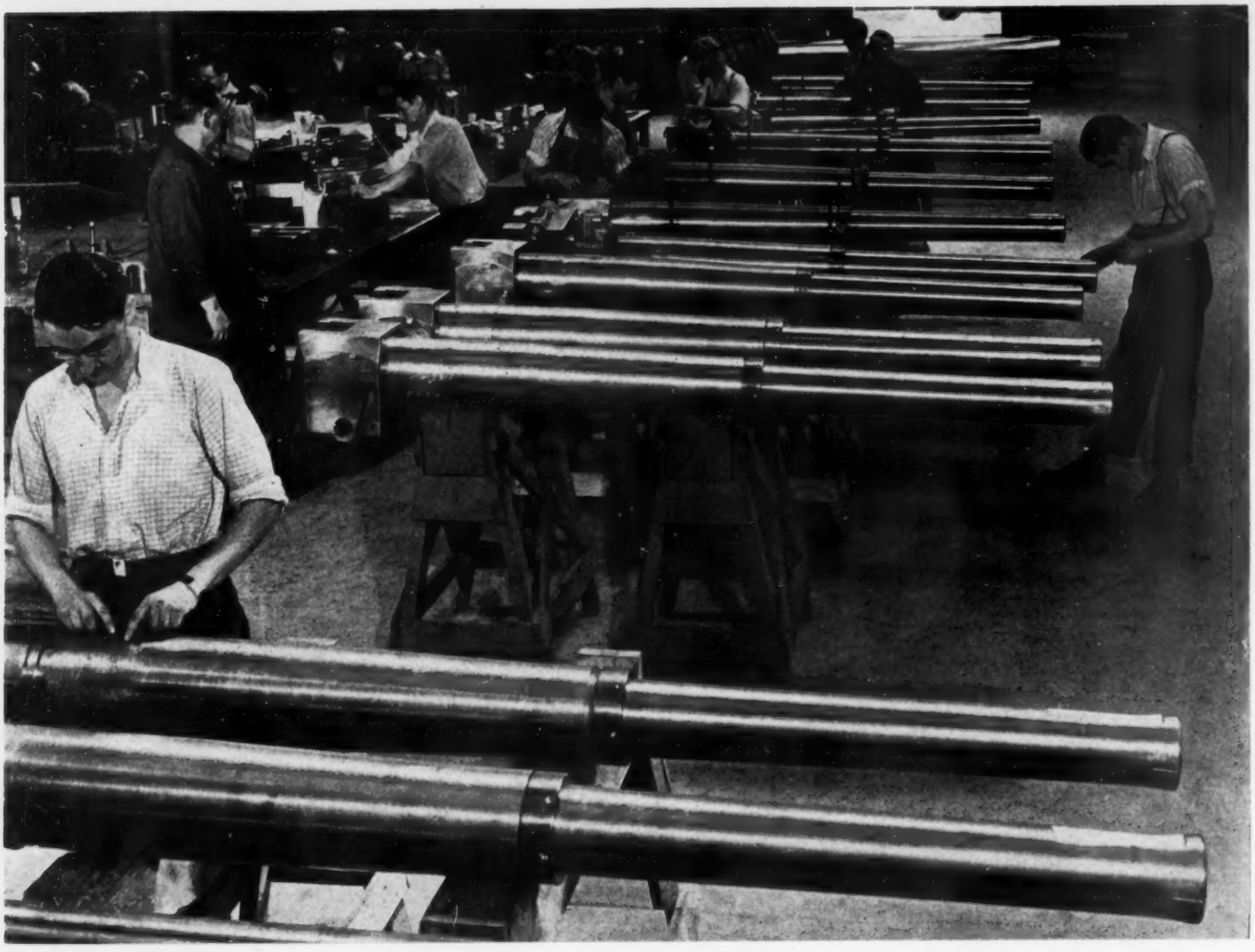
Armament

SECTION OF AMERICAN MACHINIST



canada:
ARSENAL of the EMPIRE

Steel Scrap to 25-Pounders
Shell Forging by the Upset Method
Producing Percussion Fuzes



Britain's prize field piece, the 25-pounder, is being made in large numbers. Here the gun barrels are being equipped with the breech mechanism

WHEN BRITAIN DECLARED WAR on Nazi Germany, Canada was quick to line up with the Mother Country. Parliament in session at Ottawa did not indulge in a wearisome debate. The people of Canada knew where they stood. They took their place in defense of the Empire.

Canada's chief job from the beginning was to provide two main assets to Britain—trained air men and the munitions with which to fight a war. In addition, she supplied a considerable force for overseas army duty. She took on this task under a formidable handicap.

Her population is only 11,500,000, or no more than lives in the metropolitan area of New York City. She possessed virtually no munitions industry. Her airplane industry had recently been born and was a puny child. Her steel mills had a capacity of about 1,500,000 tons of ingots a year, compared with 83,000,000 tons in the United States. Many of her plants which had turned out armament in the First World War had scarcely produced a pound of munitions since then. The machine tool industry of Canada was inadequate for a wartime task because of its small size. The shipbuilding industry was meager in scope and in facilities.

It is no exaggeration to say that Canada started from scratch to build an arsenal for the Empire, an arsenal presumably out of reach of Germany's bombers. If the first eight or nine months of the war did not bring startling results, the fault was scarcely Canada's. Everyone looks back, not without astonishment, at the prolonged period during which the war often was referred to as the "phoney war." Little happened in western Europe, and France and England went almost unscathed. And England was loathe to place large war orders outside her borders, even in Canada. With the exception of certain segments of her industries, and of the air training program, Canada reluctantly marked time.

But when France fell with a crash almost overnight, the character of the war effort changed quickly. Canada's armament effort went into high gear. Britain needed help badly; and she got it. New plants went up faster than ever. Tooling for munitions production was given a clear track over everything else. Expenditures for direct and indirect war operations rose steadily. Direct defense spending in the current year ending next April 1 will be $1,450,000,000 or twice the amount during the previous year. Total expenditures

Canada

will be considerably more than $2,000,000,000, and will require 35 to 40 per cent of the national income. They will be the equivalent of an expenditure by the United States for defense and for aid to Britain of about $30,000,000,000.

The pride and joy of Canadians in their war effort has been the extraordinary progress of the British Commonwealth Air Training Plan which was first announced in December, 1939. It is now graduating thousands of pilots, gunners and observers at around twice the rate originally scheduled for this time. It operates 83 schools from coast to coast.

The plan was devised to reach a peak in 1942 when it was expected that Britain's airplane output would soar to an unprecedented height. As a matter of record, the plan has far exceeded expectations and is a contribution to Empire defense of inestimable value.

Canada's present-day record in armament manufacture is impressive. One factory, which began production of Bren guns before the war and is now producing much ahead of schedule, is said to have the largest output of all automatic gun plants in the world. An $8,000,000 plant to make automatic guns for airplanes is being erected.

Fourteen types of land and naval guns and ten types of mountings are being produced or are soon to be produced in Canada. Mortars are being turned out, and 25-pounders are in production. Anti-aircraft gun barrels are being made in sizable quantities. Small arms ammunition factories are manufacturing tens of millions of rounds of ammunition monthly and can enlarge their production should it be necessary or desirable. Shells and shell components are well up to manufacturing schedules. Nine types of gun ammunition are being made at the rate of millions of rounds a year. Aerial bombs and rifle grenades are being produced.

With Canada more prepared than any of the other Dominions to provide mechanized equipment, she has done a superlative job. She has been manufacturing mechanized vehicles: ammunition carriers, troop carriers, machine gun carriers and radio cars. Ford of Canada and General Motors of Canada have been producing these units at a high rate. Canadian-made motor military vehicles have been an important factor in British campaigns.

Canadian industry also has gone in for tank manufacture. Private shipyards in the Dominion have been expanded sharply, though only small ships can be built. Most attention has been given to production on a "line" basis of so-called "corvette" boats, which are about 180 ft. long and 800 tons. Expansion of shipbuilding has been so great that next year about 1,000,000 tons of new ships will be turned out.

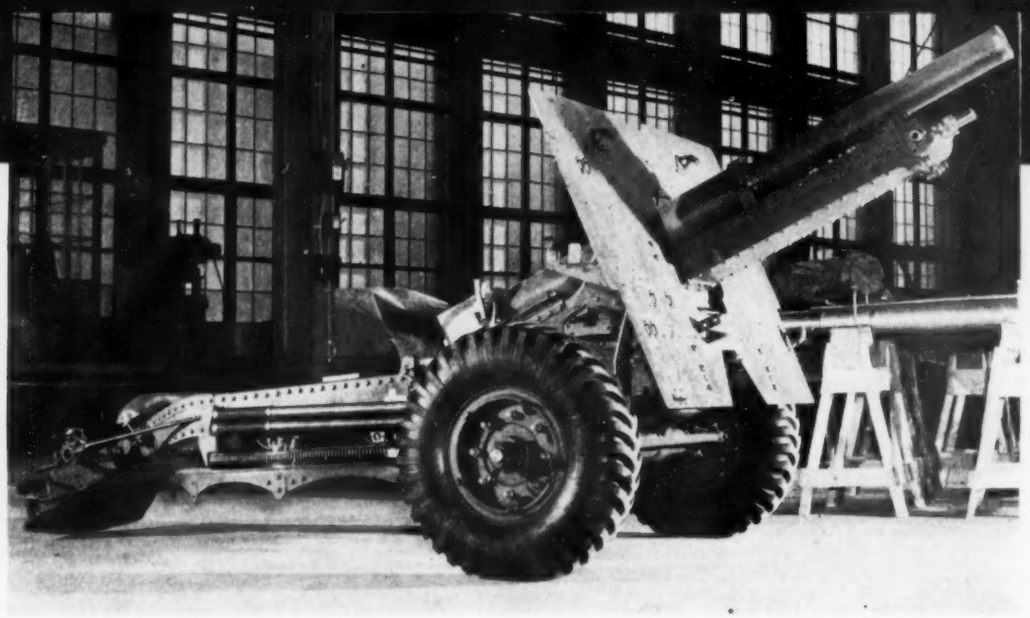
Canada thus is proving herself to be an important arsenal of the Empire. In time her contribution will be even larger. On the following pages are the details of the processes used in some Canadian factories to build munitions for Britain.

Arsenal of the Empire

Photo—Public Information

Symbolic of Canada's defense of the Empire is this armed guard standing night watch over one of the Dominion's busy munitions works

Canada is building cruiser tanks at the shops of the Montreal Locomotive Works



The 25-pounder gun now largely replaces the 18-pounder familiar during the World War. It is Britain's prize field piece

STEEL SCRAP TO 25-POUNDERS

Sorel Industries, Ltd., new from the ground up, has become an outstanding supplier for Canadian and British armies

SOREL, a small French-Canadian town in the St. Lawrence Valley, has been transformed into a busy manufacturing center by the war needs of Great Britain and Canada. Prior to the outset of the war Edouard Simard, a member of a prominent Sorel industrial group enlisted the co-operation of the Schneider-Creusot interests in France, and obtained a small order from the British Government. Technicians were brought over from France, and during August, 1939, construction of a modern plant began. Machine orders were placed simultaneously and by April, 1940, the first machine was put into operation.

K. T. Keller, Chrysler's president, greets Edouard Simard who first conceived the idea of a huge armament plant at Sorel and initiated its construction

When June came and France fell, the key technicians whose families were still in France, returned home. In order to continue production, and increase the capacity, the Canadian Government set up a joint operation with the Simard interests, the project being administered by a Control Committee. They invited the Chrysler Corporation of Canada to supply the lacking technical and production men. As a result, 25-pounders are today rolling off the assembly line at Sorel in increasing quantities.

Sorel Industries, Ltd. is said to be the only artillery manufacturing plant which make guns and carriages complete from scrap iron to the finished weapon. With the exception of a few specialized parts such as optical equipment, wheels and tires, and a few small components, everything for this weapon is made at Sorel. The plant includes four main manufacturing units, a laboratory, a power house, storage buildings and a new administration building. It covers 14 acres and incloses over 600,000 sq. ft. of floor space. The buildings house over 700 machine tools and 7,000 jigs, tools and gages. An unusual feature of the machine shop where heavy turning is done is the arrangement for chip removal. Chips fall through floor gratings into shop trucks on the basement level where they can be carted away without interrupting the work.

At present Sorel Industries employs approximately 2,200 men of which about 85 percent are French-Canadians. Three-quarters of them have been recruited from the Sorel district. Many of these men had to be trained for their jobs. This activity is continuing and today 375 men are taking the Sorel course.

The modern well equipped buildings of Sorel Industries, Ltd., grew from empty fields in the short space of two years. They are now devoted to the manufacture of the 25-pounder gun

The 25-pounder gun proper consists of the barrel, the jacket and the breech mechanism, the largest components of which are the breech ring and the breech block. The steel scrap from which these parts are made is received on river barges which are unloaded by means of a huge crane and transported on flat cars to the scrap storage pile. The selected scrap used is cut up into appropriate sizes for furnace charging by shears or by the oxyacetylene torch. Such material as billet croppings, railroad wheels, scrap shell and machine turnings, are used. Under the careful control of the metallurgical laboratory, this material is melted in two electric furnaces of four and eight tons capacity respectively. The charge is combined with alloying elements including about three percent nickel.

When the melting process is complete, the furnace is tapped into a ladle, and the molten metal is cast into ingot molds. After solidifying, the ingots are kept in a coaking pit until ready for blooming which is done in a 2,000-ton press.

Further fabrication to bring the steels to workable size, is carried on in forging presses and in steam and air hammers. In the forge shop, parts ranging from small drop forgings to large billets for the barrels, jackets, breech rings and breech blocks are formed. For smaller sized bars a rolling mill has been installed. It is interesting to note that this mill is the same one that was used by the Ford Motor Company in its exhibit at the Chicago Fair.

Billets for the barrels are cut off on the ends in a cold saw and then centered by means of portable drills. The next operation is rough turning which is done on a double-carriage engine lathe. Then the barrels are rough drilled in a center-drive machine with the drills fed from both ends simultaneously. High-speed drills are used with tips shaped much like the ends of twist drills. A heavy flow of cutting compounds flushes the chips.

At this point the barrels are normalized. For this operation and for other heat-treatment on the barrels and jackets, ten vertical electric furnaces are installed at Sorel. Eight of these are capable of handling barrels up to 28 ft. in length.

After normalizing, the barrels are straight-

Sorel is unique in that its operations embrace virtually every step from the scrap pile to finished gun. Here an electric furnace is being tapped into a ladle prior to casting the ingots

ened, if necessary, in a hydraulic press and are then rough and finish bored in engine lathes. Double edges high-speed steel cutters are used with the bars guided by bronze pilots. Cutting oil is supplied through holes in the boring bars. The barrel chamber is then roughed out.

Following this, the bore is honed. The outside diameter is again turned and polished smooth at four points along its length for the auto-frettaging process which comes next.

Auto-frettaging is a process which gives desirable characteristics of strength and wear to heavy steel tubes. It consists of expanding the tube radially by applying hydraulic pressure to the bore; the pressure used is sufficient to exceed the elastic limit of the metal in the bore. This action causes the metal in the bore to yield plastically and maintain a permanent set. The outer layers, which are not stressed beyond their elastic limit attempt to return to their original dimensions.

The result is much the same as when steel hoops are shrunk on the outside of a tube. The inner wall is in a state of residual compression and the outer wall in a state of residual tension resulting from the cold working received during the process.

As performed, on the 25-pounder gun barrel, the two ends of the barrel are counterbored, reamed and threaded to a shoulder. This permits making the appropriate connections. One end of the barrel is connected through a high pressure pump, while the other is connected to a specially designed valve which releases the liquid, a combination of water and glycerine, through a pressure gage.

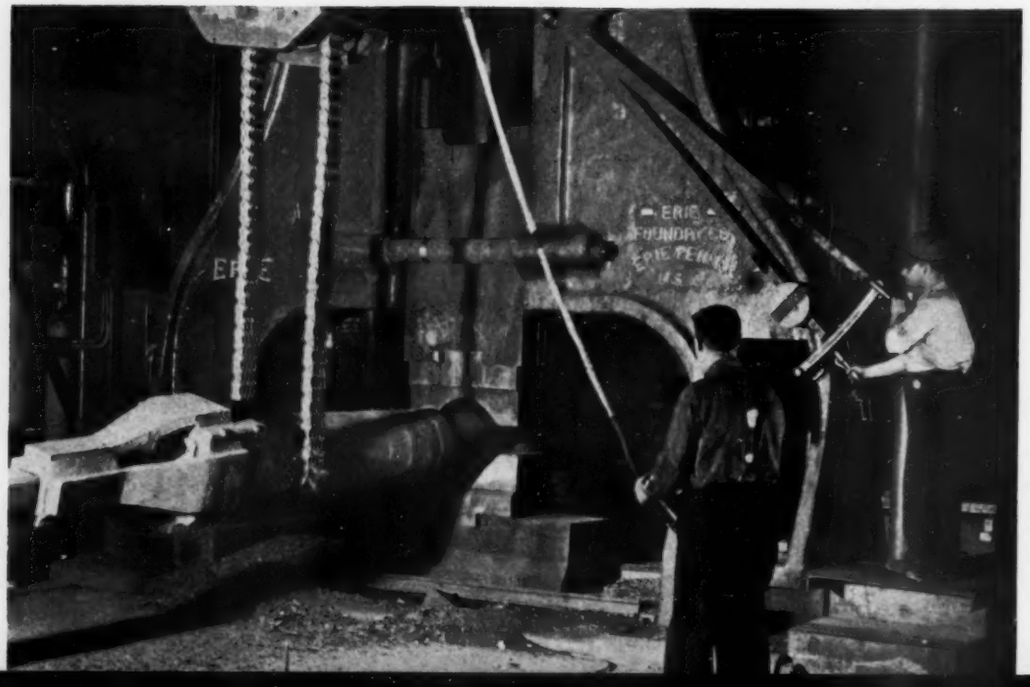
Core Bar Reduces Liquid Required

Before the gun is set up, a steel core bar is placed in the bore. This core is bored for a short distance at both ends, and at the inner end of each of these holes, a radial hole is drilled. The course of the liquid is through the core out through the first radial hole to the outside diameter where it passes along between the barrel and the core bar and reenters the second radial hole at the opposite end. This arrangement reduces the quantity of liquid required.

After the pipe connections have been made, indicators are placed at the four points along the length to obtain readings on diameters 90 deg. apart. The pressure is applied in four steps with readings taken at 20, 24, 28 and 32 tons per sq. in.

An interesting feature of the pressure valve

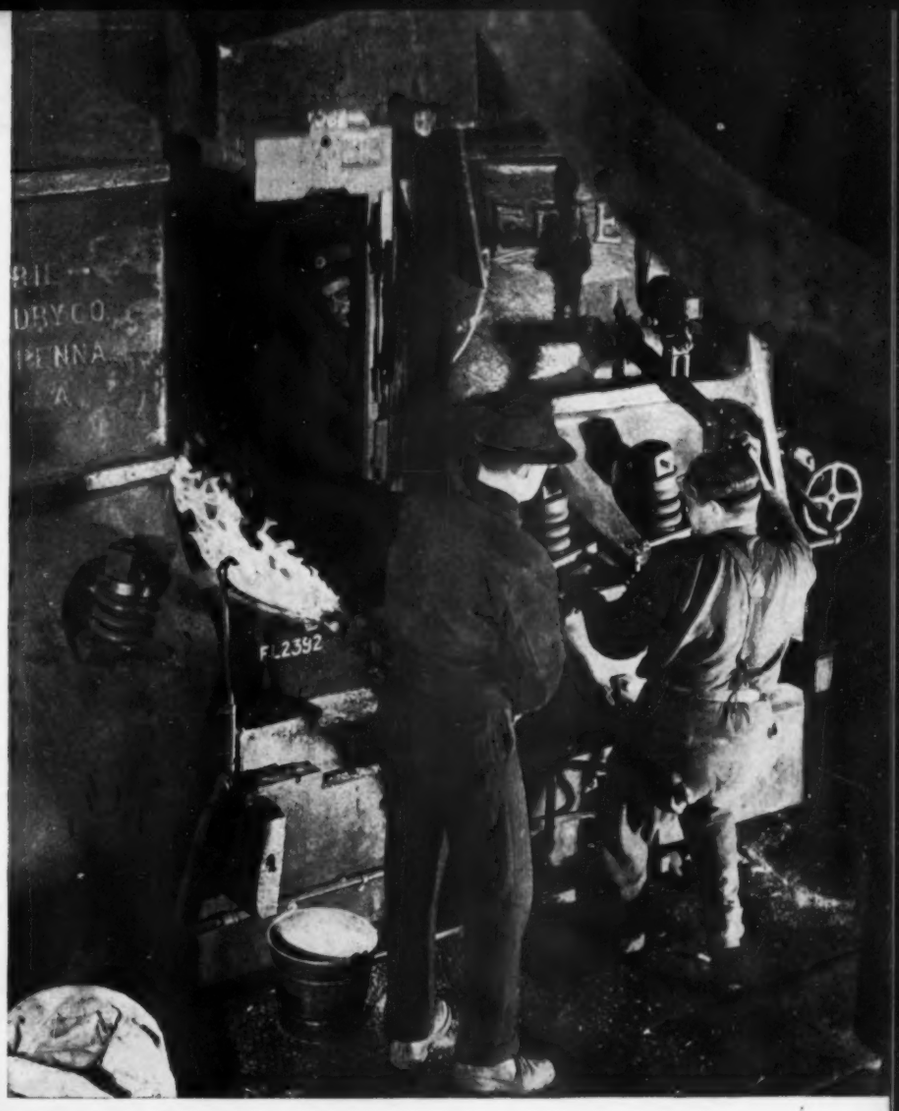
Barrels and jackets are hot worked in a steam hammer to form billets of suitable dimensions for the turning operations which follow



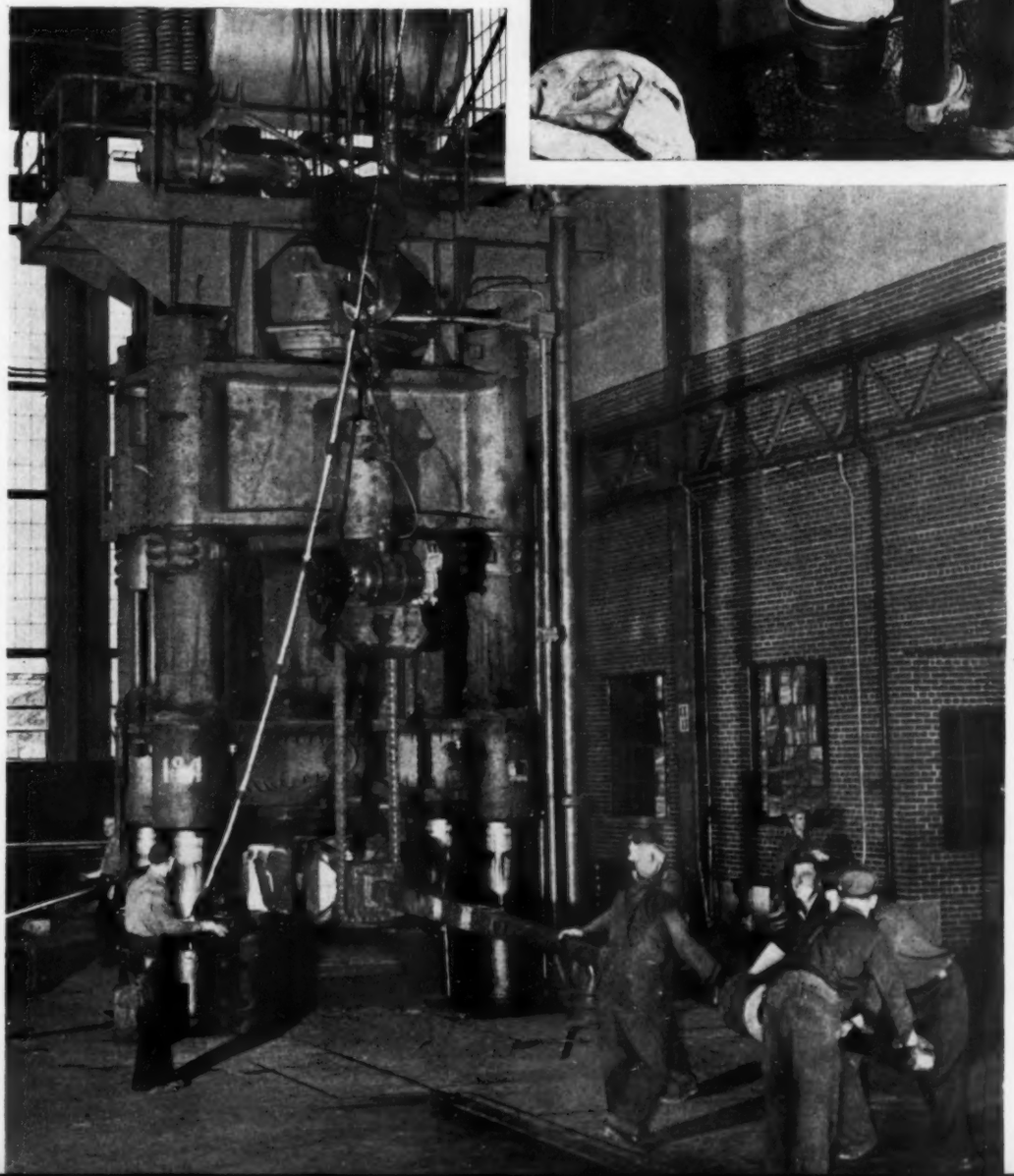
is that it is equipped with an accurate scale to measure pressures up to 50 tons. The dial of the gages is calibrated on a scale at the plant to obtain accurate readings.

Before the barrel is set up for auto-frettaging it is carefully measured in the bore and on the outside at the four spots polished in the lathe. Outside measurements are made with micrometers and inside measurements with a pullover gage and micrometer. At each increment of pressure the outside diameter of the barrel is again measured at the same four points at two diameters at right angles to each other. These readings are taken by precision dial gages reading to 0.0001 in.

The readings taken while the pressure is being applied are plotted on charts and their positions noted in relation to standard stress curves. From this it is possible to ascertain the amount the elastic limit has been exceeded which is an indication of the degree of cold working of the gun bore. Variations in the size at points along the length make possible



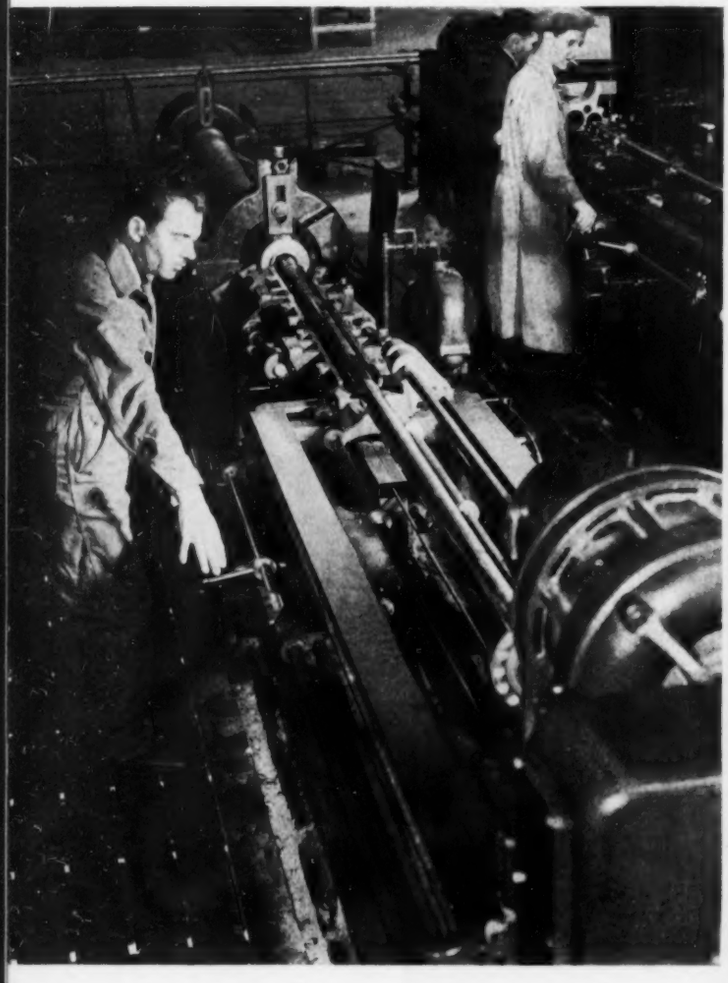
Small parts are drop forged. This forging will become the elevating arc, one of the components of the carriage



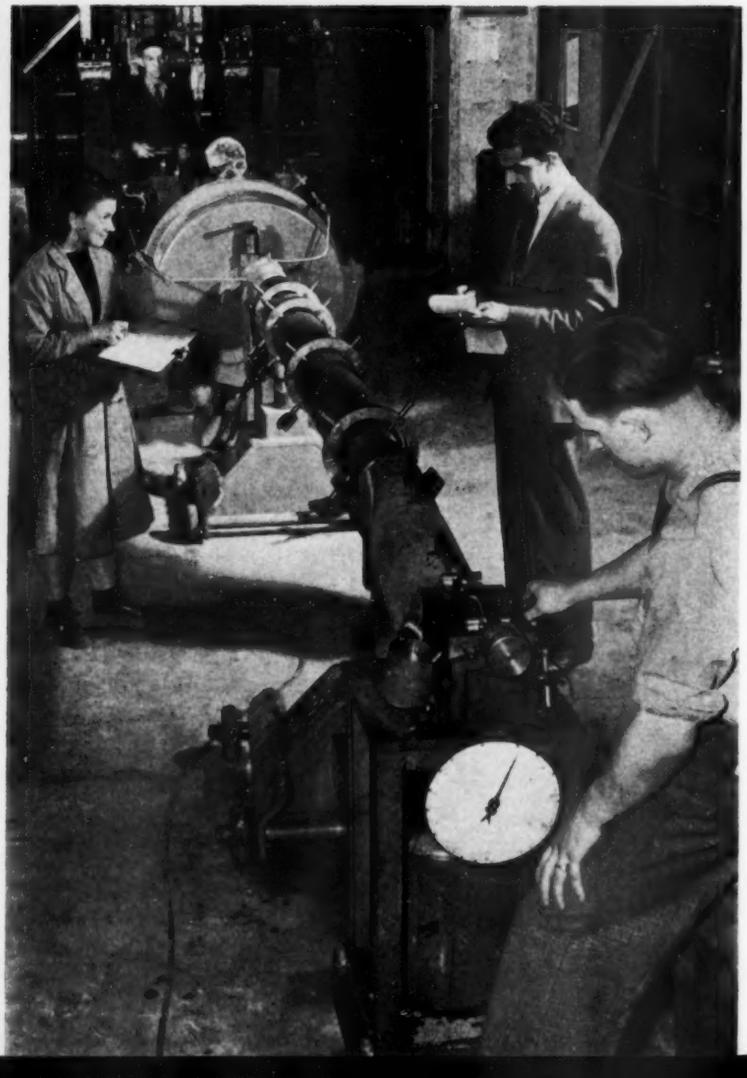
A huge blooming press performs the first steps in bringing the hot ingot down to size and shape for further forging operations

Barrels are drilled in a center drive lathe of modern design which permits working simultaneously from both ends. Chips are flushed out by a heavy flow of cutting oil

Final finish on barrel bores is given by honing. This operation is also performed as a preliminary step to auto-frettaging



During the auto-frettaging process dimensional readings along the outside of the barrel are taken while the internal pressure is increased. The man at the near end operates the pressure valve and controls the pump by means of a foot switch



the detection of any irregularity in the expansion of the metal under pressure.

After the 32 tons per sq. in. load, the pressure is released and the liquid is drained out of the barrel. It is then given a low-temperature anneal in one of the vertical electric furnaces previously mentioned. Auto-frettaged steel barrels are unstable and must be aged or followed by a low temperature heat-treatment. If over tension is followed by a low temperature anneal, the steel recovers and the elastic limit increases to a value equal to or greater than the auto-frettaging pressure.

Pressure Applied Second Time

After annealing, the barrel is again returned to the auto-frettage set-up for a test pressure. This time the hydraulic pressure is brought up to the maximum of 32 tons per sq. in. in a single step, and dimensional readings are taken again. If any irregularity has been caused by the treatment it can be noted at this time. After the pressure is removed readings are taken on the outside diameter and in the bore at the same four points.

Auto-frettaging expands gun barrels of this size from 0.012 to 0.020 in. in the bore and from 0.006 to 0.010. in on the outside. The difference between these two figures measures the permanent set of the barrel. The steel on the inside has been compressed which changes the structure throughout approximately half the cross section of the wall.

After the pressure test the barrel is given a second heat-treatment. Then the ends are cut off including the threaded portions which were used solely for connecting the fittings during auto-frettaging.

The barrels are again set up in a lathe and bored to 3.35 in. Then they are set up on plugs in an engine lathe for a second turning operation on the outside diameter. Another boring operation brings the barrel to 3.440 in. inside diameter.

At this point it is necessary to rehone the bore. The first honing was done in order to obtain a good gaging surface for the auto-frettage operation, and the finish obtained is subsequently destroyed by heat-treating and reboring. Rehoning brings the bore to final size and destores the highly finished surface.

A centering plug is then put in the muzzle end of the barrel and held in a chuck while the breech end is held in a steadyrest. In this set-up the final chambering operations are performed.

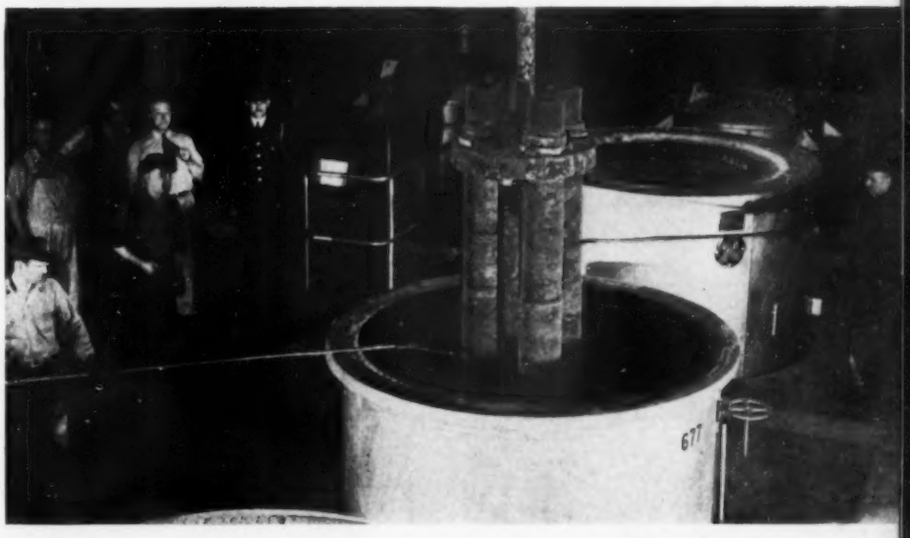
The outside surface is then ground for the jacket; the barrel is given a slight taper. In two lathe operations the outside of the breech end is finished, the front cone is turned and the barrel faced to length.

The rifling operation follows. This is done in a machine which uses a sine bar mechanism for generating the helix of the rifling groove. As the carriage for the rifling bar travels along the bed of the machine it carries with it a slide, the end of which is guided by the sine bar attached to the bed. To the underside of the slide is bolted a rack which meshes with a pinion keyed to the rifling bar. As the carriage moves longitudinally the rifling bar is given a rotary motion according to the degree of angularity of the sine bar.

The forward end of the rifling bar carries a two-toothed cutter which machines two rifling grooves simultaneously. These cutters collapse into the bar automatically at the end of the stroke so they will not drag on the return stroke and mar the grooves. After the bar is withdrawn from the bore the cutters are pushed out to their initial position and are then expanded an additional amount for the next cut. This procedure continues until all the grooves have been completed. After each pair of grooves is finished the bar is indexed to the next two with the cutters reset to their starting position. As in all rifling set-ups a liberal supply of cutting lubricant is forced through the hollow bar to wash the chips away so they will not damage the cut.

With the exception of a few milling and drilling operations, this makes the barrel ready for fitting. Extractor clearances and a flat on the muzzle end for the climometer are milled and air release holes are drilled in separate operations after rifling is completed.

In general the turning and boring operations on the jacket parallel those on the barrel. However, a few variations should be noted. Jackets are first machined in pairs;



The full effect of auto-frettaging is brought out by heat-treatment. These electric furnaces are used for barrels and extend to a depth of 28 ft.

that is, the stock is rough turned and drilled in sufficient lengths to provide for two jackets. After rough drilling, the jackets are cut to 55-in. lengths in a cold saw. At this point samples for chemical analyses are taken. Jackets are given only one heat-treatment which immediately follows this operation.

Since the jacket bore is larger than that for the barrel it is possible to use multiple tooling. A bar with seven tools is used, and these are set up with each one slightly higher than that preceding it in order to approximate a taper. A wood packing guides the bar. Then a continuous cut is taken to give the jacket bore its taper, leaving about 0.015 in. for grinding. The grinding operation is done with a special grinding attachment mounted on the tool carriage of an engine lathe.

Two other steps on the jacket differ from those on the barrel because of its design. A buttress thread must be cut on the breech end to receive the breech ring. In addition the jacket is fitted with three annular segments or thrust bands which engage the recuperator block and transmit the force of the recoil to the recuperator mechanism. These details are first roughed out and then finished in lathe set-ups. Since both the buttress thread and the thrust bands are interrupted, the unwanted portions of them are removed in the milling machine.

After this work has been done, the jacket is carefully laid out, and the horizontal and vertical axes are marked. The jacket is then ready for assembly with the barrel.

Billets for the breech rings and the breech blocks are descaled by the oxyacetylene flame before machining in long lengths on four sides. These operations are done on a planer before the billets are cut to suitable lengths for making the individual parts. About fourteen breech blocks and eleven breech rings are obtained from a billet. After the parts have been sawed apart, the front and back faces are milled in horizontal milling machines.

The breech ring then has a 2½-in. hole drilled in the center in a radial drilling machine. It is then bored part way through a 3½-in. diameter in a second milling machine set-up. At this point it is heat-treated, drawn and tests coupons cut or trepanned out.

The breech opening is roughed and finished in a vertical milling machine and the actuating shaft clearance is cut. The breech side of the ring is surface ground in order to square that face for setting up for the turning operations. In a lathe set-up, it is rough and finish bored and threaded to match the jacket; then located from the threads, the piece is returned to a vertical milling machine while the outer surfaces are machined. These surfaces are then ground in a large surface grinder.

After auto-frettaging and the subsequent test pressure, barrels are gaged inside and out. Bore dimensions are checked by using a micrometer over the outer end of the pullover gage

Many Milling Cuts Used

A large number of milling operations follow and include cuts on the breech opening, the recesses for the block and the angles on both sides. The hinge holes and actuating shaft clearances are bored and faced in a horizontal boring machine.

At this point a master breech block is fitted to the ring, and two bronze bushings are pressed into place. Interruptions in the buttress threads are removed in a vertical slotter with the ring located from its bore. Another series of minor milling operations perform such steps as chamfering the angles and radii on all sides of the ring, cutting the climometer recess and firing bracket pocket and machining the breech block stop. Drilling and fitting makes the breech ring ready for assembly with the jacket.

As has been pointed out, the first operations on the breech block are similar to those for the breech ring. After the blocks are cut off from the long billets, the load holes and cartridge gaps are rough drilled before the blocks are heat-treated. As with the breech ring most of the operations on the block are performed

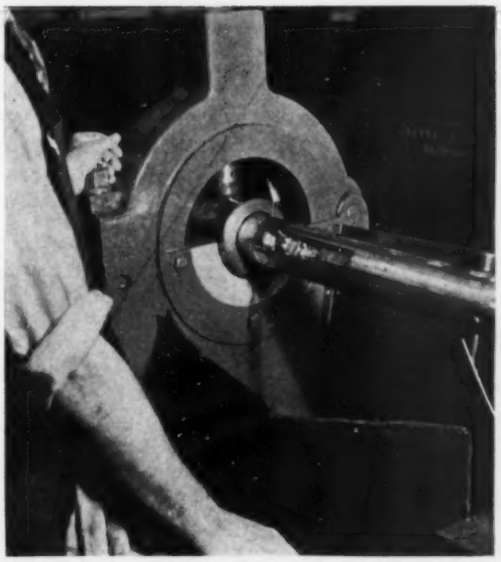
A block which slides in a sine bar gives a rotary motion to the rifling bar as the carriage travels back and forth along the bed

in milling machine set-ups. The faces are ground on a surface grinder on four sides, four blocks being set up on the table at a time.

Another piece that is machined from a long billet is the recuperator block. The ends of the billet are sawed off, and then the block is planed eight pieces at a time. These operations include top, bottom and sides with the bottoms being cut into steps to reduce the amount of stock necessary to remove later by form milling. The breech end face is then machined in a shaper. The top profile is also planed and then rough form milled including the radius to form the storage tank.

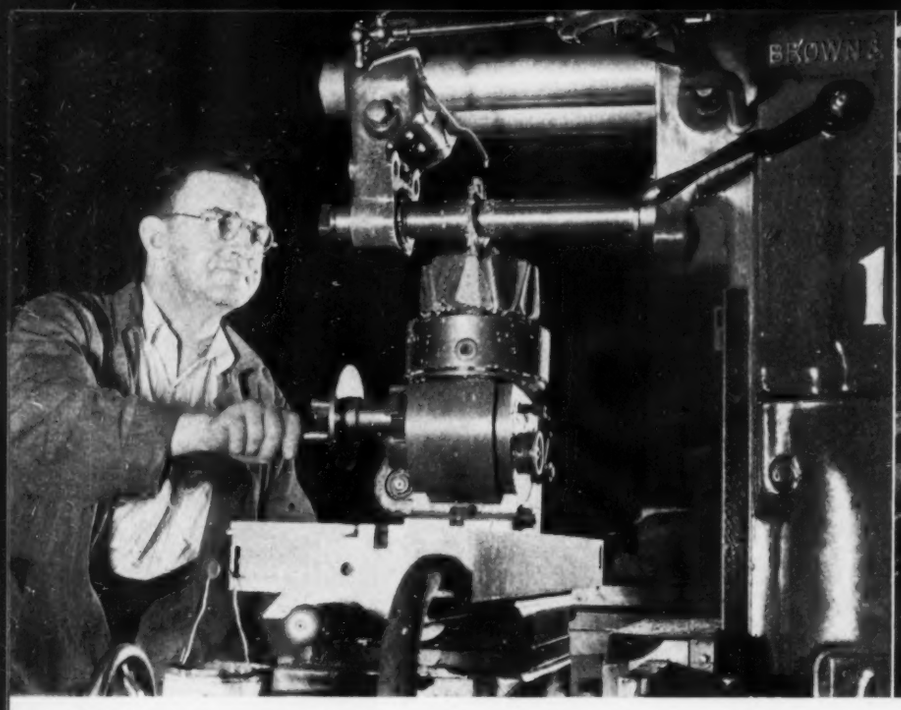
It should be explained that the recuperator block contains four bores running through its entire length which control the recoil and recuperator mechanism. These cylinders are drilled in a lathe using a special fixture. The block is mounted in a frame which consists essentially of a pair of rings a little farther apart than the length of the block and held together at opposing points on their diameters by cross bracings. One of the rings is clamped to the faceplate while the other runs in a steadyrest. A hole in the center of the ring away from the faceplate carries a drill bushing.

The block is located by its corners against fixed stops in the rings which brings the air cylinder directly in line with the spindle of the lathe and the hole in the bushing. In this position the air cylinder is drilled. Similar fixtures are used for drilling the buffer cylinder, the recuperator cylinder and the storage tank, which is also a cylinder designed to re-



The rifling cutter automatically recedes into the bar on the return stroke and comes out during the cut. It is adjusted outward an additional amount for the feed

A ticklish operation on the breech ring is done in this engine lathe set-up. Here the ring is bored, counterbored and threaded, using a four-position toolpost



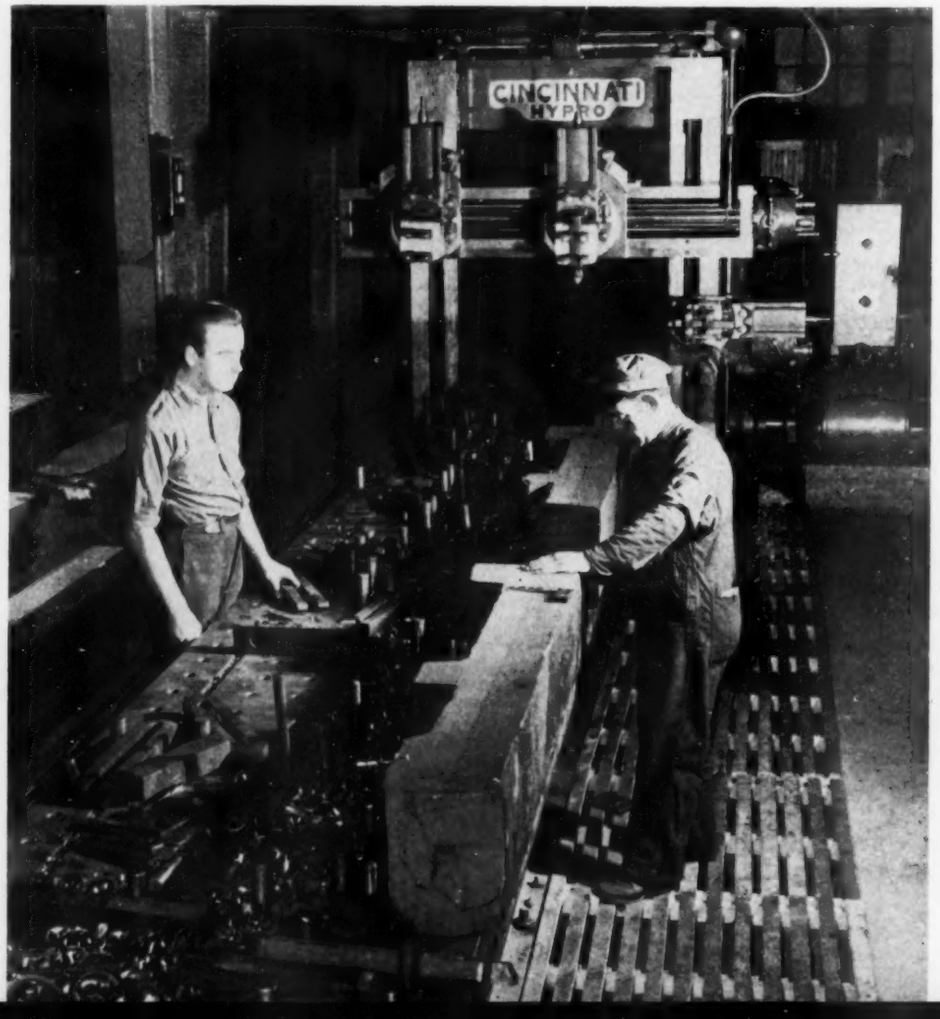
Sorel has its own toolroom where it makes special cutters, gages and fixtures. This large milling cutter set up on a dividing head is typical of this department's output

Another operation on the recuperator block is to mill the bearing brackets which engage the gun jacket on assembly. This view shows some of the form milling cuts previously taken

ceive the recoil dampening liquid when the gun is fired.

After the drilling operations, the block is again planed, top and bottom and both sides, leaving 0.100 in. at the corners for finish. This operation trues up the block and corrects any distortion that have occurred during the drilling. Then the block is bored, two holes at a time by means of a special fixture on an engine lathe. By means of a gear train, two boring bars are driven simultaneously from the headstock and are supported on the tailstock of the machine. A special table attached to the lathe carriage locates the recuperator block. When set up in this position, the block is carried along the length of the lathe bed while the boring bars first rough and then finish bore the holes. The two remaining cylinders are rough and finsh bored separately.

After the ends of the cylinders are counterbored the block is again put on a planer to finish the corners to their final dimensions. With the exception of the storage tank the cylinders in the recuperator block are honed.



Recuperator blocks forged from ingots from Sorel's own steel furnaces are set up on a planer for the first machining operation

This is done on the same type of machine used for the barrels. From 0.012 to 0.015 in. is removed by honing.

The block is tested and then subjected to a hydraulic pressure test. Test pressures on the various cylinders range from 3,000 to 5,000 lb. per sq. in. except for the storage tank which is tested at 40 lb. per sq. in.

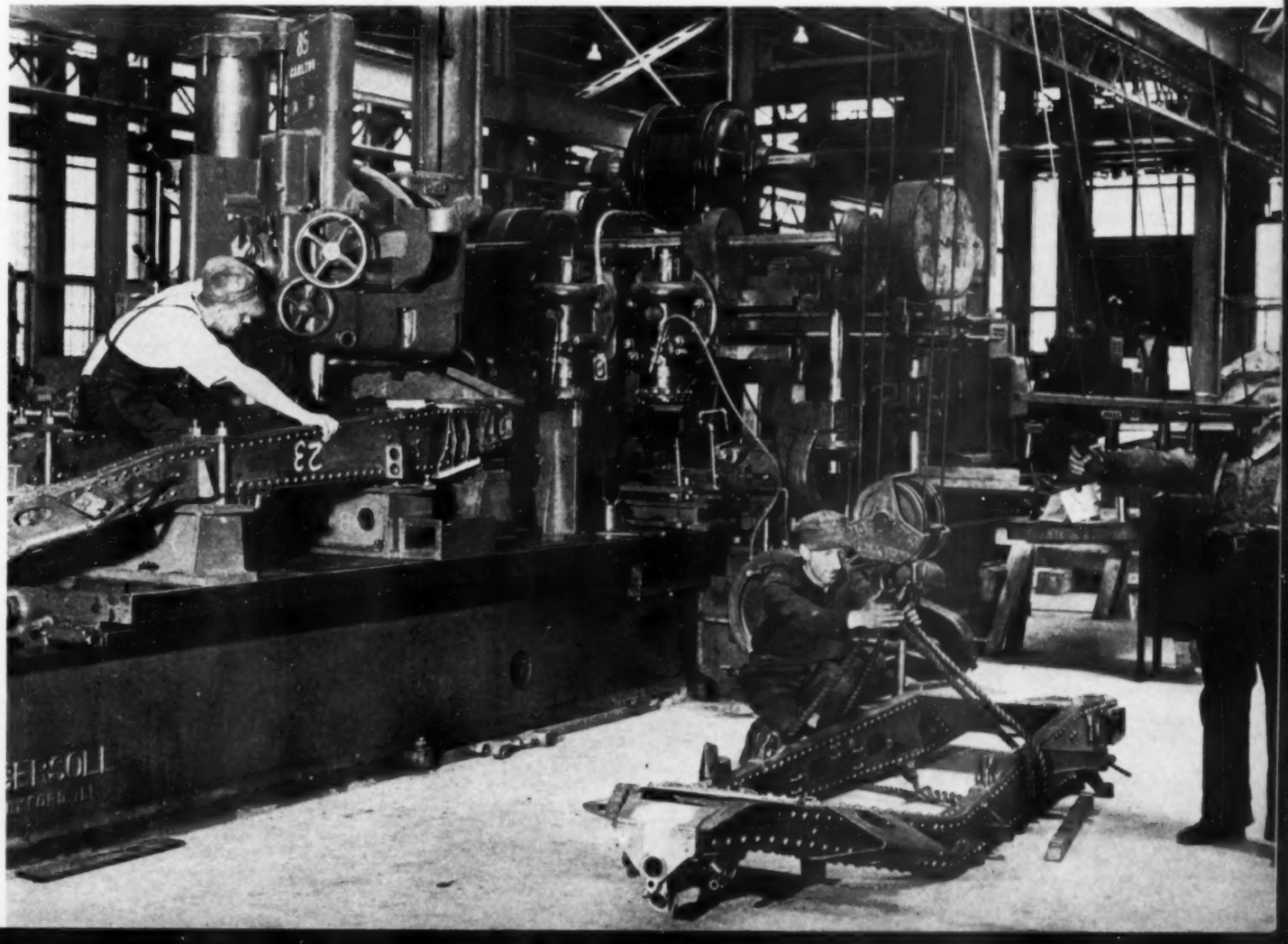
The cylinders after the test are counterbored, undercut and threaded. A number of smaller drilling and milling operations follow to form a number of port and valve openings and locating points for the bearings.

The buffer cylinder is rifled with grooves that are approximately ½ in. wide and 0.100 in. deep. These grooves have a slight helix angle and are used to operate the valve mechanisms incidental to the functioning of the recuperator mechanism. They are cut in the same kind of machine used for the barrels.

A series of small cuts on drilling and milling machines following the rifling operation makes the blocks ready for assembly. The first step in assembly is to add the liners which are on the outside of the block at the four corners. These are fastened to the block with countersunk screws and are then planed in place. The block is then inspected all over and the cylinder plugs are fitted. The recuperator block engages the thrust rings in the jacket and in turn slides in a component called the cradle which is of fabricated steel.

In addition to the gun proper, 25-pounder gun carriages are made at Sorel. The carriage is a fabricated job built up chiefly from structural shapes and plates purchased from outside venders. The plates are cut to shape either by the oxyacetylene flame in shears or on nibbling machines. Rivet holes are punched in the plates using gang set-ups where possible to save time.

The gun carriage shop occupies one of the large manufacturing buildings at Sorel. The main components of the carriage are the trail, the saddle, the firing platform, the shield and the axle. Of these components only the axle requires any considerable machining. Since this is merely a cylinderical shaft turned down at the ends the operations on it are entirely conventional. The shield is bulletproof and like the trail, firing platform and saddle is made up of plates assembled by rivets. Some of these parts, particularly the firing platform, resort extensively to the use of assembly jigs. In this way their accurate alignment is assured, and the high degree of workmanship employed on the gun proper is carried through the entire assembly.



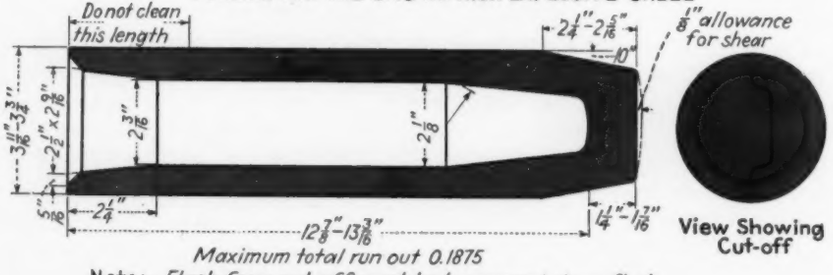
Most of the work on the gun carriages consists in fabrication by forming and riveting. However, an interesting machining set-up on the trail uses a radial drill and a planer type milling machine to take eight cuts

SHELL FORGING BY THE UPSET

BECAUSE OF its position in the commercial forging industry, a certain Canadian plant elected to make shell forgings on upsetters, which will have widespread application after the war. Geared to war-time production and possessing experience from making several hundred thousand shell, this plant has served as an information center for shell plants in the United States.

Shell forging is segregated from commercial activities. The layout of the rectangular building is such that floorspace is conserved, and the shell need be moved only short distances. Upsetters and heating furnaces are placed in a row lengthwise of the building and separated from the wall by a space sufficient for the forging crews. Immediately behind each unit forging installation there is an inspection station. Down the center of the plant runs a cooling conveyor, which also serves to store shell. The other half of the building is utilized for shotblasting and inspection activities, and storage of shell in skid boxes awaiting truck or rail shipment to the shell-machining plants. Floorspace is conserved to such an extent that the plant is less than 100 ft. wide.

FORGING FOR THE 3.45 IN. HIGH EXPLOSIVE SHELL



Maximum total run out 0.1875

Note:- Flash from cut-off must be hammered down flush with end of forging to clear ⅝" dia. center

Several kinks in forging the 3.45 in. H.E. shell lighten the machining load. These include a chamfer at the nose to reduce facing, a short steep taper at the nose end of cavity to reduce machining prior to nosing, and a taper on the tail to approximate the outside contour. Shell forging weighs 35 lb., is machined to 20 lb. 5 oz. Dimensions are approximate

Since forging is done from the end of the bar, no facilities are required for sawing, shearing or breaking billets. Bar steel, mill-cut to length for several shell, is received by railroad on the side of the building adjacent to the furnaces. Roll-up doors give quick access to outdoor steel storage, bars are quickly lifted by hoist and charged into the heating equipment. Maximum ventilation of the heating and forging area is a desirable by-product of the side-wall construction.

Shell sizes and types vary from time to time with the contracts placed by the Dominion authorities. The 3.45 in. high explosive shell has been chosen to illustrate the application of the upsetter method. This 25-pounder shell (loaded weight) has a comparatively thick wall, and in this respect is different from most shell made in the United States.

A unit shell-forging installation consists of an upsetter flanked by two slot-type oil-gas-fired furnaces closely controlled for temperature at any heating portion of the slot. Reasons for choosing this type of heating equipment were: (1) it was desired to forge from the end of long bars, instead of using single or double length billets, 2) the first cost of the slot-type furnace was less than with other types of fuel-fired furnaces and the required floorspace was less, (3) induction heating of shell steel was out of the question because of the economics involved and because of problems with additional power loads in a city operating under war-time conditions, and (4) to secure a type of furnace that could readily be duplicated in Canada, in view of the overloaded condition of the furnace building plants in the Dominion and the United States. Surface Combustion engineered the first furnaces, then permitted the Canadian plant to build additional units of the same design.

Furnaces Burn Gas and Oil

The furnaces are automatically controlled. Temperature is maintained uniform at all portions of the furnace hearth by an unusual arrangement of a *number* of thermocouples. Another new feature is that oil and gas are burned simultaneously, and thereby the best advantages of both types of fuel are secured. Thus, the furnace design provides high luminosity and a high heating rate, together with flexibility of atmosphere control afforded by gas combustion. Fuel consumption is said to be exceptionally low per ton of steel, but data are not available for publication. Burners are set to provide a type of scale that is readily removed on half-round scraper plates attached to the front of the furnace. Steel loss in the form of scale is slight.

Thirty 2⅞-in. round bars are heated simultaneously in each furnace. These bars are purchased from the mill in correct length to make five forgings, including allowance for a short collar between them. It takes approximately 40 min. to bring the end of a bar to forging temperature.

A seven-man crew serves a unit forging installation as follows, two men handling bars to and from each furnace, two forging-machine operators and a man on top of the National forging machine to swab the punches and dies with graphite in oil. According

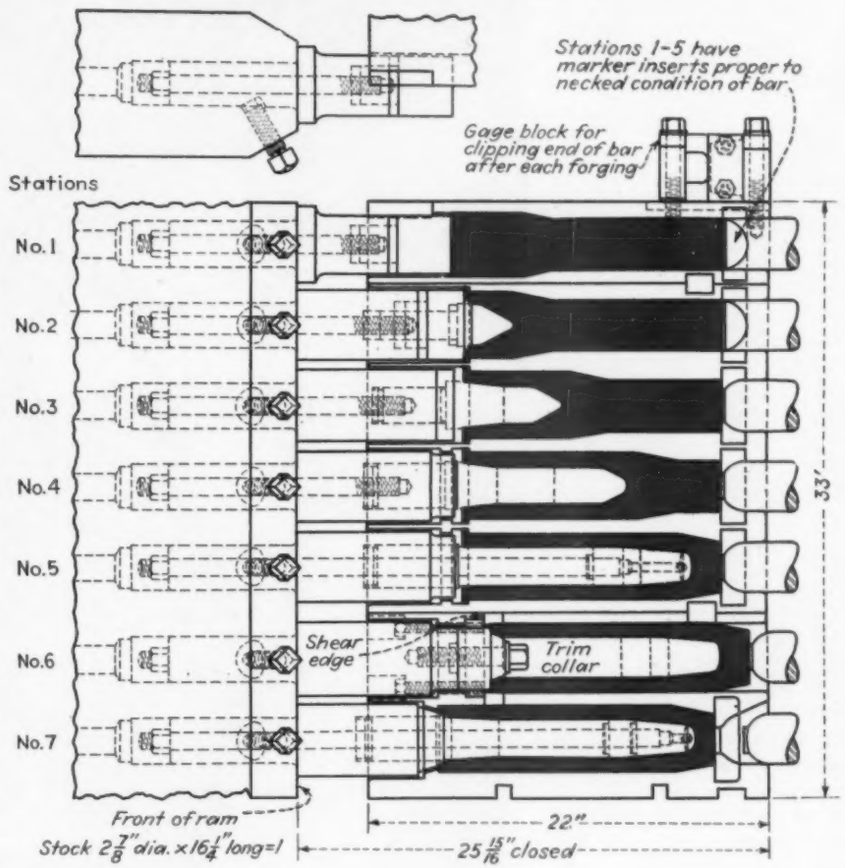
METHOD

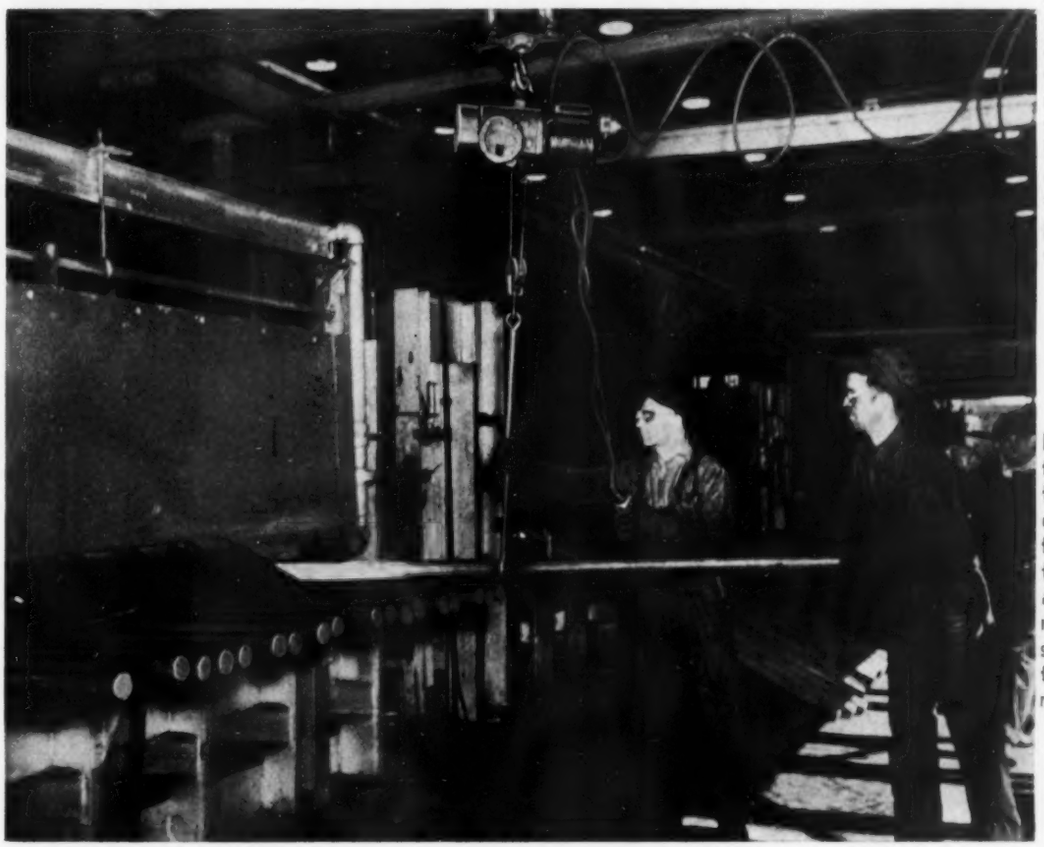
to the trend of thought in United States shell-forging plants, a seven-man crew constitutes an excessive labor burden. The Canadian plant has good reasons for following its current practice, and it should be understood that it also serves domestic customers with forgings in mass-production quantities.

The machine and general overhead burden for each forging installation is determined from an exact cost analysis. Labor is a relatively small fraction of that burden. By adding a couple of men, as compared with forging crews in the United States, production is lifted a score or more shell per hour and the over-all cost per shell is reduced. Moreover, the extra production is of vital necessity. In other words, the management does not hesitate to throw labor into a job on the customary premise that a given percentage of overhead must be added to the extra labor burden.

A well-trained crew, operating with the rhythm desirable in production, will turn out 100 of the 3.45 in. high explosive shell forgings per hour. This is a net figure, as averaged over the shift, and includes time lost in changing punches and dies, but not for machine repairs. The cycle is as follows in

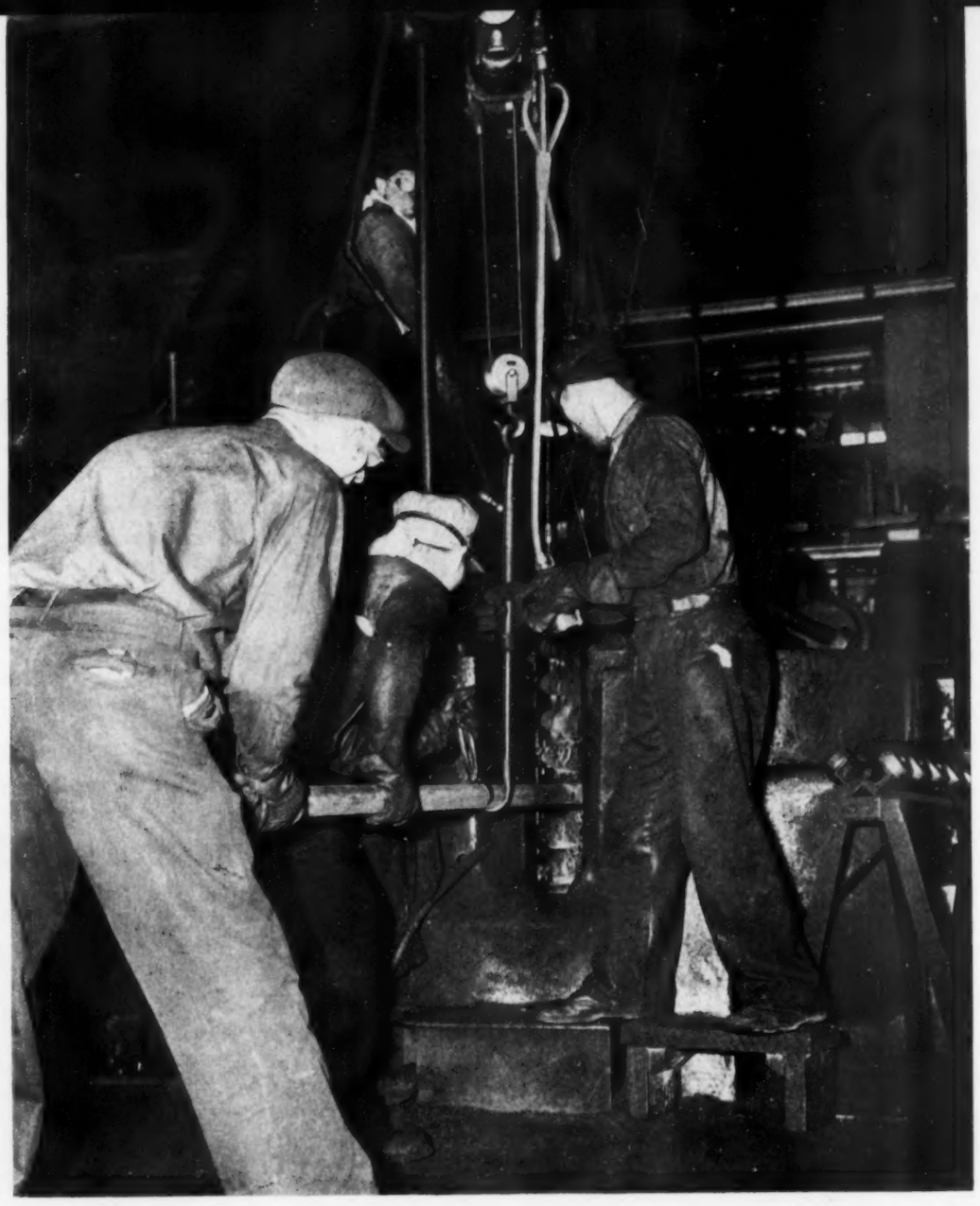
PUNCH AND DIE ASSEMBLY FOR 3.45 IN. H.E. SHELL





Seven-impression dies are required to forge the 3.45 in. H.E. shell. The locating collar is trimmed at the sixth impression. Punches at stations 5 and 7 have vent-holes in the tip to relieve gases pocketed at the bottom of the cavity. All punches are adjustable for depth by means of washers

Each upsetter is flanked by two slot-type bar heating furnaces. A furnace crew consists of two men, who transport a heated bar to the upsetter with the aid of an electric hoist on a monorail. Soft, loosely adherent scale has been scraped off the bar by means of a half-round scraper at the furnace entrance position



A seven-man crew for a unit forging installation includes two men on each of the two furnaces, two machine operators who work alternately, and a man on top of the upsetter to swab the dies. Shown in position at the machine are: one of the forging operators at front left, and the crew from one furnace who lower and guide the bar from impression to impression at the operator's command. The bar is turned 90 deg. at successive stations to avoid ridges in the forging at the die partings

operating the 6-in. National forging machine. Assume that a shell has just been forged from a bar heated in the left-hand furnace. The crew for that furnace takes the bar away on an electric hoist suspended from a monorail and the No. 1 forging operator steps back to rest. The crew for the right-hand furnace is already walking into position with a heated bar. Forging machine operator No. 2 steps into position to guide the bar end progressively from die to die. One man of the furnace crew operates a hand switch to lower the bar from die to die. The second man positions the cold end of the bar when there is an appreciable overhang beyond the hoist. For short bars the second furnace operator is not required.

Inspection Follows Forging

When the shell has been forged in the last die impression, the second furnace operator upends the bar to break the shell off at the base. Then he and the hoist operator walk the bar back to the furnace, while the forging machine operator tosses the shell down the chute to the inspection station at the rear.

In effect, two teams of three men each work at the forging machine turn and turn. At a speed of 100 shell net per hour, there is a little time for rest, and those moments are essential under the strain of a long work week.

The seventh man (on top of the machine) swabs the punches and dies with a graphite compound just before the dies close. A pump directs a spray of water and soluble oil upon the punches and dies to cool them as rapidly as possible. The swabbing with graphite follows to provide a measure of lubricating action and thereby decrease wear of the punches.

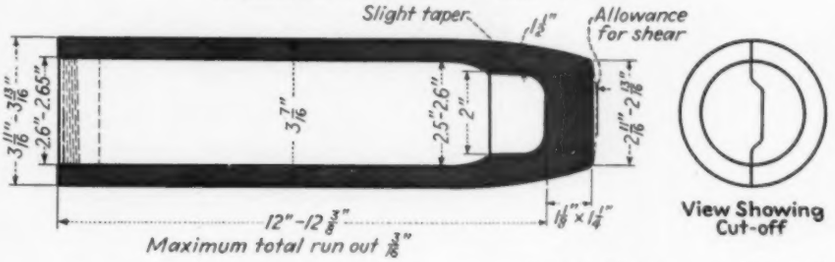
The 3.45-in. H. E. shell, which is heavy and involves deep piercing, was allocated to a 6-in. upsetter, one size larger than usual, to avoid machine downtime at the rate of production desired. The oversize machine also pro-

vides increased die space, which makes it easier to hold the dies in position.

Seven-impression dies are employed for forging the 3.45 in. high explosive shell. At the top of the tools there is a gage block for clipping the collar left from forging the previous shell. Station No. 1 has a flat-ended punch for flattening the clipped end of the bar and partially upsetting that end, while at the opposite end a marker insert indents the bar for location purposes in the next impression. Flattening the stock promotes concentricity in the piercing operations that follow, while upsetting at this stage is essential to control the length and amount of stock in the forging. Station No. 2 commences the piercing and upsets the end of the bar to full O.D. for the shell. This impression is important because it establishes the center for further piercing operations. Punches at Stations 3, 4 and 5 act solely as piercers, dividing the work approximately among them. No further upsetting is performed, the punches merely opening the upset to the shell O.D. Equal division of work among the three punches follows accepted practice. Station No. 6 trims the collar, and Station No. 7 finish forms the entire cavity and establishes the base thickness.

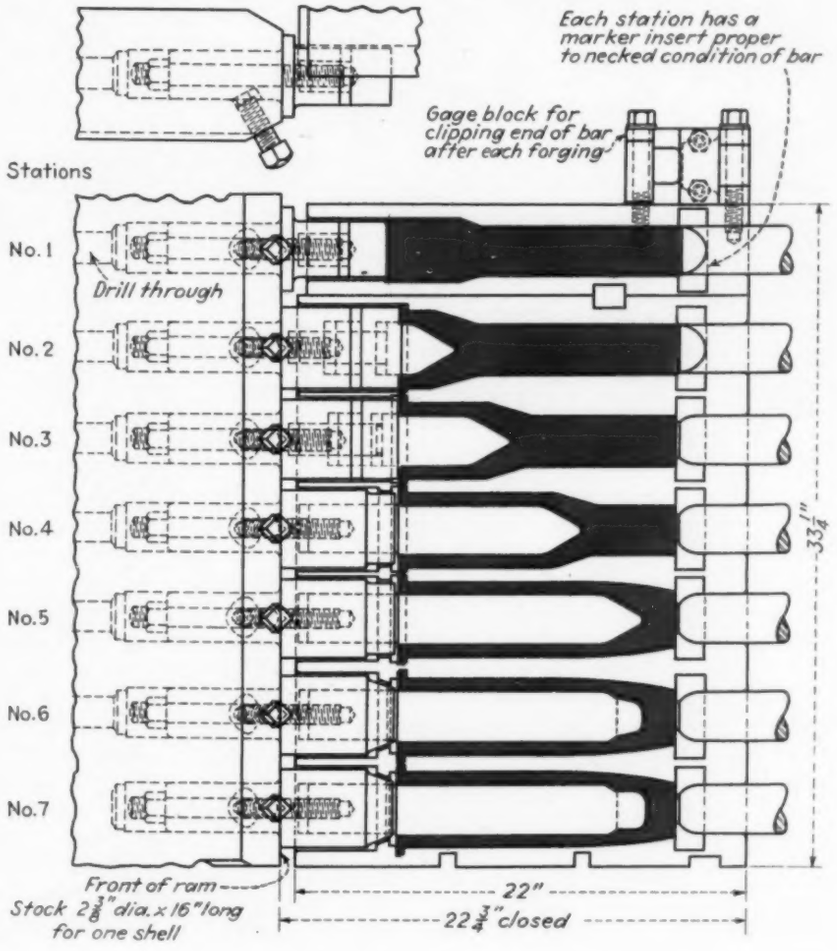
It will be noticed from the drawing for the 3.45 in. high explosive shell that the cavity is tapered from the nose to the base. When a straight hole is specified in shell, the Canadian forge plant tapers the piercing punches up to ten minutes per side to minimize scoring when the punches are withdrawn from the hot

FORGING FOR THE 3.45 IN. SMOKE SHELL



The 3.45 in. smoke shell poses several forging problems because its cavity exceeds the bar diameter and the wall is thin. Several hundred thousand were made to specifications at the net rate of 100 shell per hour, but a boring operation was added later to ease the forge-shop's problems. Forging weight, 18 lb.; machined weight of shell, 12.5 lb. Dimensions shown are approximate

PUNCH AND DIE ASSEMBLY FOR 3.45 IN. SMOKE SHELL



Two die impressions were found necessary form the dome at the nose end of the 3.45 in. smoke shell. Die space of the upsetter limited the tools to seven impressions. Hence the collar is trimmed in a secondary press operation

steel. The limits for diameter at either end of the hole usually will permit this practice to be followed. In development of shell the tendency is to avoid a straight hole and a flat bottom, to ease the forging problem, but perhaps specifications can not always be changed to suit the forge shop's convenience.

Punches Carefully Heat-Treated

Punches are made from hot-die steel of the following composition: 0.30 per cent carbon; 0.90 per cent silicon; 0.27-0.35 per cent manganese; 4.75-5.00 per cent chromium; 1.00-1.25 per cent tungsten; 1.50-1.60 per cent molybdenum. Heat-treatment involves: (1) preheat at 1,000 F. for two hours; (2) transfer to controlled-atmosphere furnace at 1,550 F. for 20 min.; (3) transfer to controlled-atmosphere high-speed hardening furnace at 1,850 F. for 10 min.; (4) cool in air; (5) double draw at 1,000 F. for two hours. In other words, the steel is twice heated to 1,000 F. and held there for two hours. No polishing is done after drawing; whatever scale is on the punch is utilized to achieve a highly burnished surface in the first few piecing operations. Any hot-die steel suitable for upsetter forgings is employed for making the die impressions. These are purchased ready for use.

Forgings for 3.45 in. H.E. shell fall down a chute leading to the rear of the upsetter. The inspector in the foreground is checking the run out. Smoke shell must have the collar trimmed on the press in the background

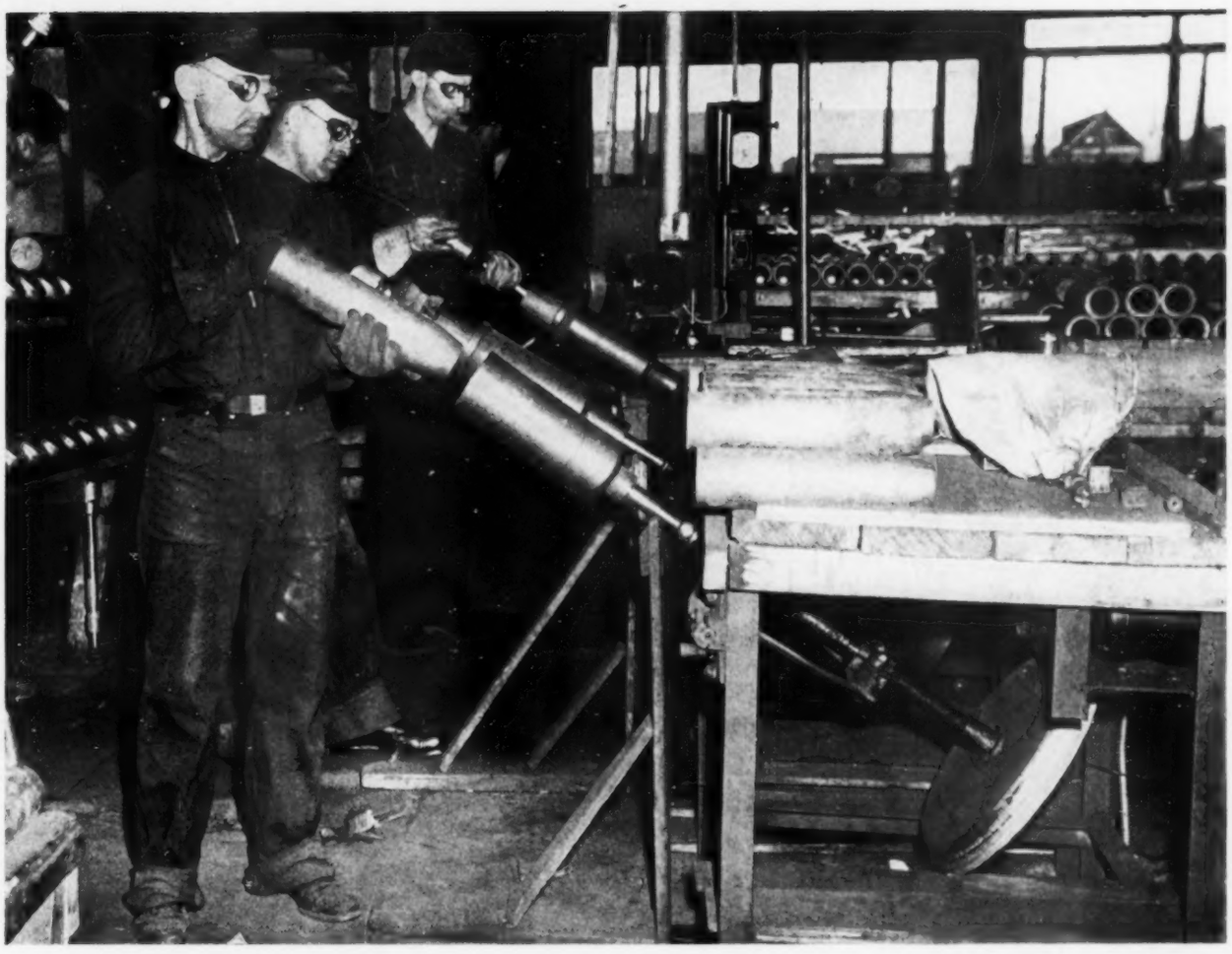
By utilizing certain kinks, the Canadian forge shop eases the load upon the shell-machining plants that receive its product. In forging the 3.45 in. high explosive shell, the open nose end is chamfered to reduce the load upon facing tools. Incidentally, a parting operation is not required with upset shell forgings. Another kink is to use a steeper taper at the nose end of the cavity to reduce the amount of metal that need be removed prior to the nosing operation. Likewise, the base of the shell is tapered on the exterior to reduce the amount of material that must be machined away to attain the shell contour at that section.

The 3.45 in. high explosive shell forging rolls down a gravity conveyor from the upsetter to the inspection station at the rear. Since the collar has been removed in the upsetter dies, the shell does not require a secondary operation, as is the case with some other projectiles. Wall thickness, depth of cavity and over-all length are checked by the forge-shop inspector, after which he slips the forging onto a mandrel for checking the run-out. Forgings that pass these inspections, as well as visual examination of the exterior and cavity, are stamped with the vendor's number and placed upon a cooling conveyor.

Forgings Cooled on Conveyor

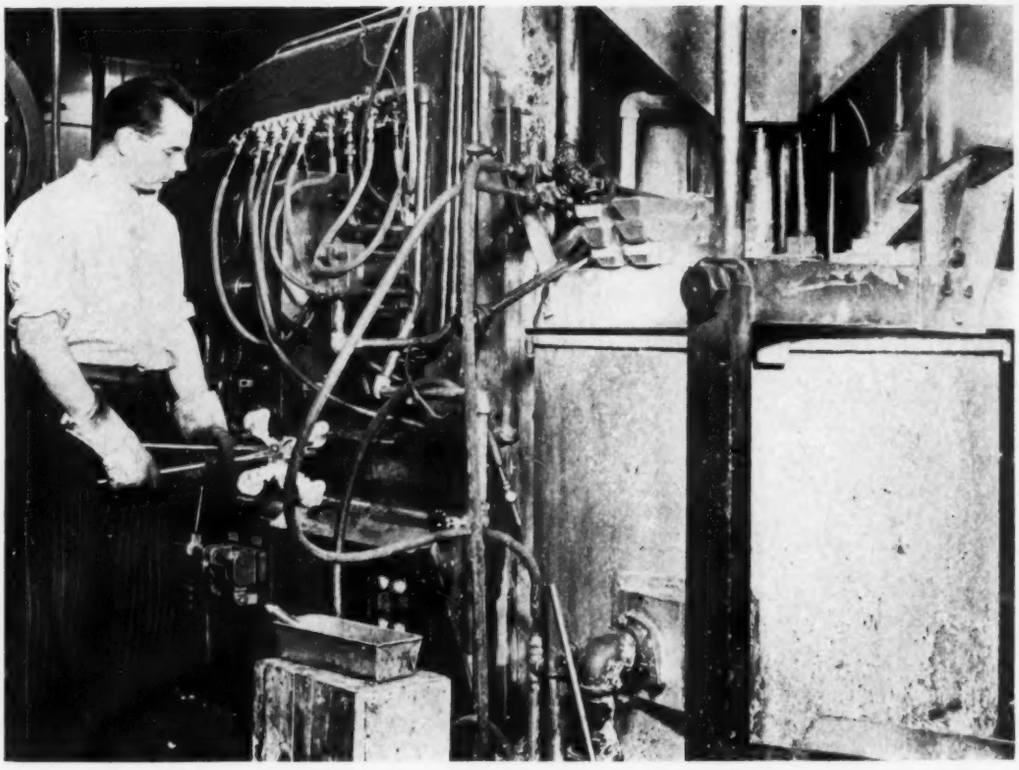
Specifications for British and Canadian shell call for retarded cooling to attain the desired physical properties, whereas American shell are sometimes given an accelerated cooling in an air blast. To cool the 3.45 in. high explosive shell slowly, they are placed on conveyor trays and a length of stovepipe is slipped over them leaving an annular air gap surrounding the hot forging. Shell travel on the conveyor for 4 hr. before they are cooled sufficiently for stacking in skid boxes, 100 forgings to the container.

Final steps include shot blasting and inspection of the cavity. Finish specifications for the cavity in shell are particularly rigid, no blemishes or pits being tolerated. Since the principal objective of the plant is to attain as many shell per hour as possible, consistent with small scrap losses, the punches are not replaced in the upsetter until scoring becomes too deep or occurs in too many shell to be handled economically in the "barber-shop." A small percentage of the output passes through this department for removal of scratches and other imperfections in the cavity. Homemade fixtures rotate the shell in a convenient position while an operator removes blemishes with a pneumatic grinder. Shell passing the shop inspector are turned over to the government inspection force.



Before the boring operation was added to the machining sequence, a small percentage of 3.45 in. smoke shell were ground internally to remove pits, scratches and blemishes in order to keep the punches operating as long as possible in the upsetter. Weight of the shell in the holder causes the pivoted fixture to tilt, thus engaging a friction-driven wheel under the bench with the driving roller. By these means the shell is caused to rotate while the operator uses a pneumatic grinder

Government inspectors check six dimensions at the shell with this homemade fixture. Inspected dimensions are: the outside diameter at two points, the inside diameter at one point, the nose thickness, the over-all length, the concentricity, and the squareness of both ends



Fuze-bodies are produced four at once in a 6-lb. cast. on a Lester hydraulic die-casting machine. The rigidity of modern equipment permits the work to be cast without flash and with only a thin, easily broken connection at the sprue

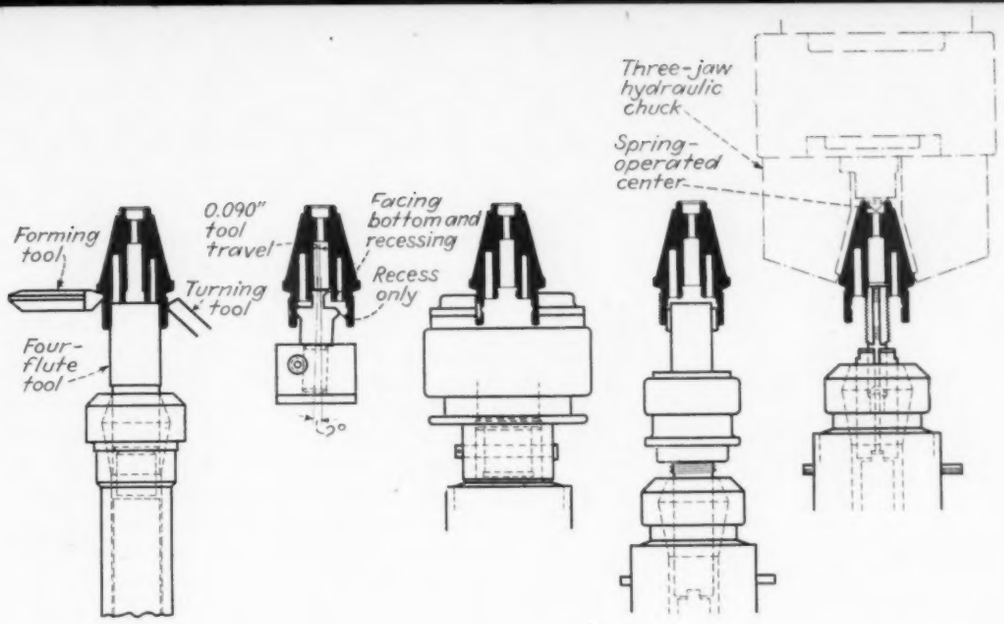
PRODUCING PERCUSSION FUZES

UPON ACCEPTANCE of contracts to make shell fuzes in vast quantities, a certain Canadian manufacturer tooled up for mass production on the theory that its task is the biggest "commercial" job undertaken so far. The experience gained in manufacturing widely diversified products has stood the plant in good stead in choosing production methods for fuzes. Most of the equipment installed is of the latest high-production pattern. These machines establish the pace on the various production lines. Operators work under the group efficiency system, and for many weeks fuze departments have attained an average efficiency rating of 110 percent.

Despite installation of the most modern tooling and the building of plant morale to a high level of efficiency, work is constantly going forward upon the refinement of processing methods and the education of workers in the importance of reducing cost. Output is a military secret, and none of the production data cited for individual machines can be used to compute the plant's production. It does run into many thousands of fuzes daily and will rise still further. An indication of the manner in which the management is constantly seeking to improve its operations is reflected by a reduction in direct labor cost of over 10 percent in a recent four-month period, despite departmental efficiencies of the order cited above. This saving reflects continual improvement in processing methods, some of which are considerable, others small, but all indicative of the value of the "commercial" approach to a war contract.

Time and percussion fuzes of several patterns have been produced in quantities. The experience gained on other orders has been instrumental in developing the setup for the percussion fuze under discussion, a type which is interchangeable upon several sizes of shell. This fuze represents the latest thought in a mechanism that will detonate properly upon striking the target but still be perfectly safe to handle. The detonating needle cannot be depressed until the various interlocks have been released by the action of the shell in flight. All of these locking devices must operate smoothly and in proper relation to one another; hence the fuze calls for precision manufacture. Total limits placed on many components are frequently in the order of 0.002, 0.003 or 0.005 in.

Because of the plentiful supply of zinc in Canada, considerable development work has



Tool layout for machining the magazine chamber in the die-cast fuze body on a six-spindle chucking machine

been done in the use of die-casting for fuze components. Three major components of the percussion fuze are produced from a zinc-base alloy corresponding somewhat to Zamak No. 3. These parts—the body, the magazine and the bottom cover—are die-cast with a saving in material cost of well over 50 percent as compared to brass, and the total processing cost is approximately one-third less.

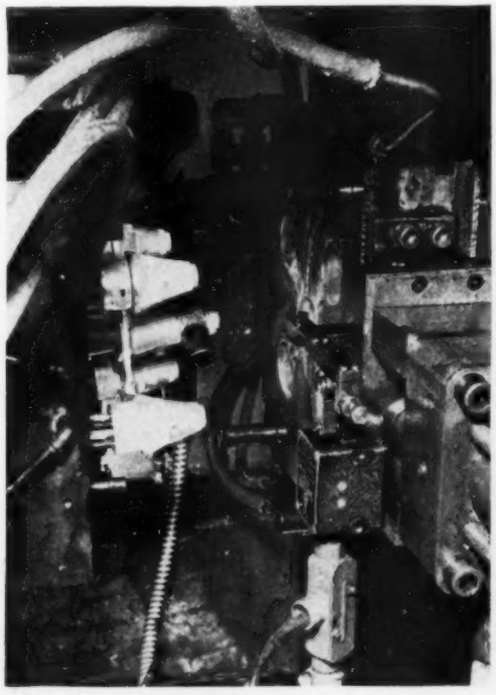
Most of the remaining steel and brass parts are produced on the latest type of screw machines, with the tooling representative of the most modern practice. A few parts, such as the upset needle pin and small springs are purchased.

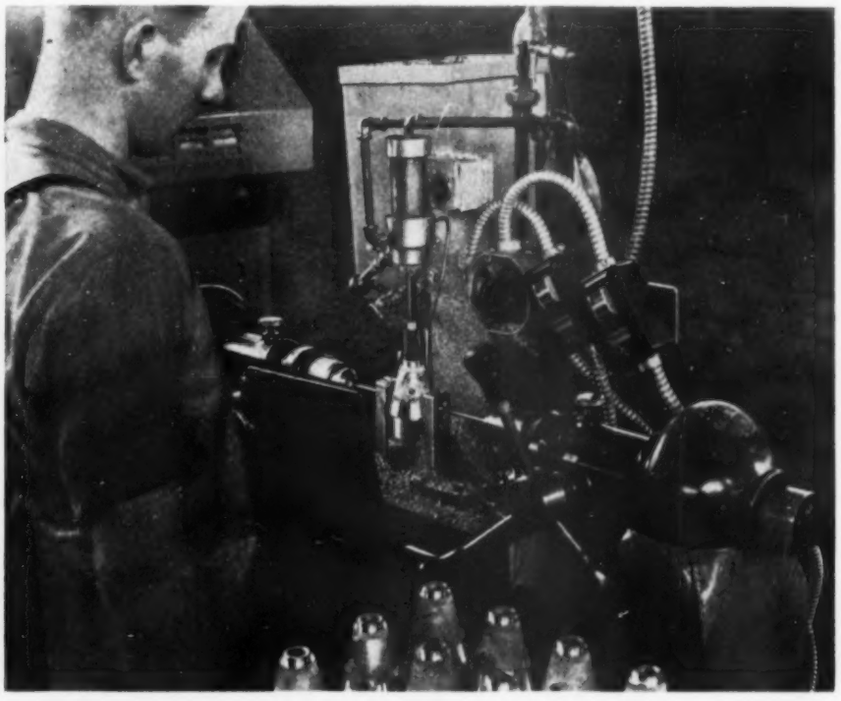
Discussion of fuze-manufacturing operations will be confined to production of the die-cast fuze body, and certain operations on other die-cast and steel parts which are out of the usual run of good practice or portray high-production methods developed for otherwise tedious operations.

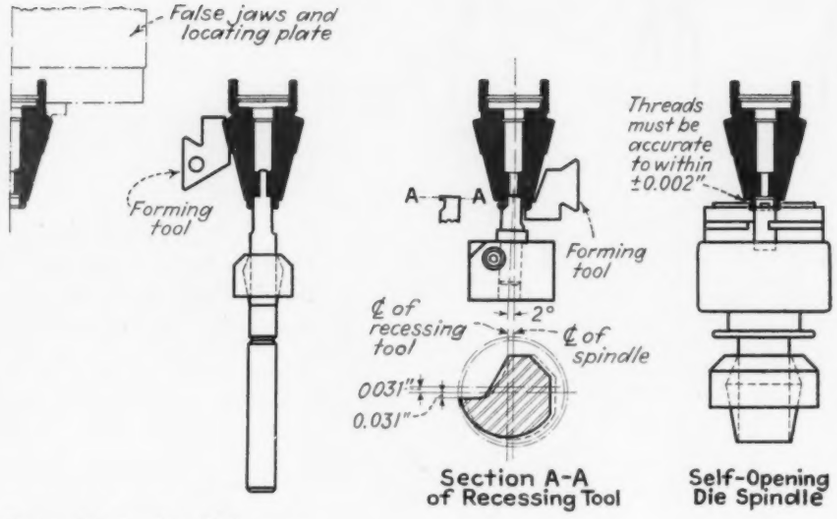
The tapered fuze body is the most difficult part to die-cast. Four pieces are produced per shot on a Lester hydraulic die-casting machine capable of 450 shots per hour to close limits. Each cast weighs 6 lb. The cast is heavily gated and the machine is capable of producing parts without flash. Hence the pieces can be broken off the sprues by hand without necessity for a trimming operation. All cores, except one, operate from the ends of the piece to produce the main bore, the swivel pin hole, and the three smoke holes. The single side-operated core produces the centrifugal bolt hole. Side-operated cores for the two wrench holes have been eliminated because drilling of the wrench holes can be

(Left below) Five cores operate from the magazine end of the body to produce the main bore, the swivel-pin hole and three smoke holes. The main bore must be concentric with the outside diameter and the swivel pin hole must be produced in close relationship to the main bore

An air cylinder coins the needle-pin hole and acts as a clamp while the two wrench holes are drilled by opposed Buffalo drillheads







To maintain the high-production rate established on the six-spindle machine, tooling of this character is employed on a four-spindle machine used to finish complete the detonator end of the fuze body

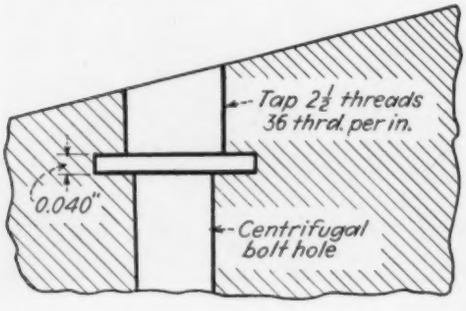
combined with another operation on the machining line.

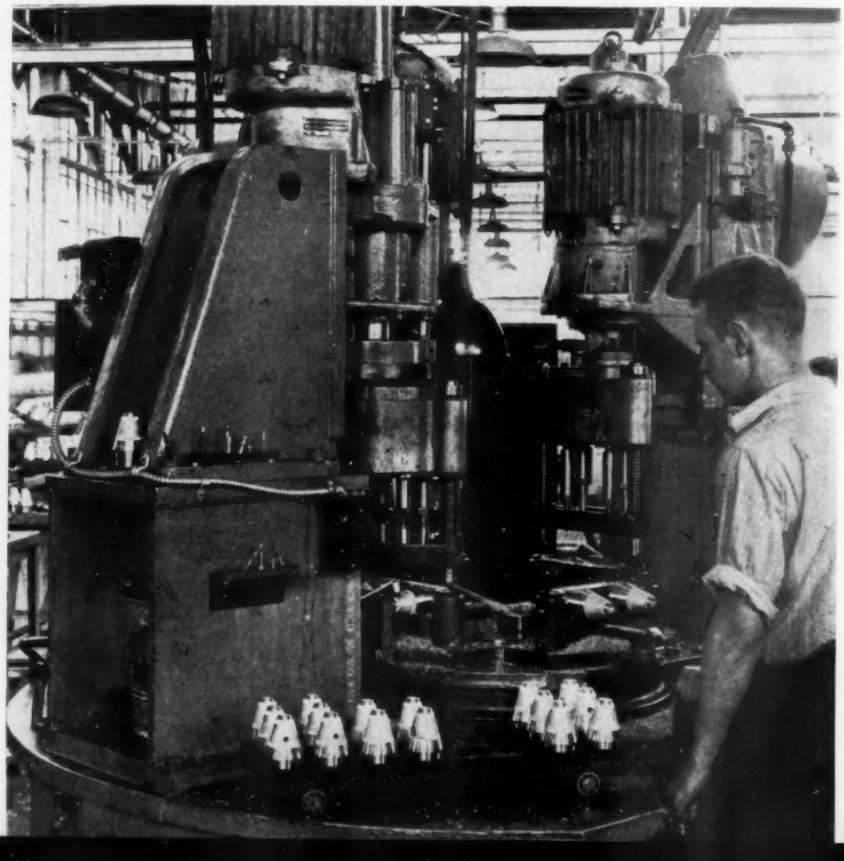
The relationship between the die-cast main bore and the swivel pin hole must be very close. There two holes, in the die-cast condition, are used for all subsequent locations in machining of the cored openings. The main bore is not machined. Once every hour, the die-casting inspector follows two fuze bodies through the entire machining sequence to see that no errors show up in machining by reason of wear or warpage of the cores producing the die-cast holes in the part.

At one time, the secondary machining operations, such as drilling, reaming and tapping of the die-cast holes, preceded the automatic chucking machines that finish the magazine and detonator ends of the body. Upon occasion, these secondary operations were found to be a production bottleneck. To prevent idle time of the expensive automatics, and to use them as the pace setter for the line, operations on the automatics now precede the secondary operations. Prior to machining, the body is stress-relieved for 6 hr. at 200 F.

A six-spindle New Britain-Gridley chucking machine is employed to perform all the operations in one set-up on the magazine end of the body. These operations are as follows: At the first, or loading station, the piece is placed on a loading pin for insertion in the three-jaw chuck. The jaws grip on the narrow straight surface adjoining the large end of the tapered body, and a spring operated center enters the die-cast striker-cover hole. On the second spindle, the outside diameter of the body is turned by a flat tool, and recessed and faced with a circular form tool, while the inside diameter is bored and faced with a four-flute tool. The third spindle has a double recessing tool for recessing the magazine bore below the thread and for recessing and facing the bottom of the detonator hole. A diehead on the fourth spindle cuts the external thread on the magazine to fit the shell nose and the internal thread is tapped at the fifth position. At the sixth spindle, the detonator hole is tapped. Production approximates 200 fuze bodies per hour. This output can be exceeded, but there are reasons not connected with the job itself which dictate the stated rate of production.

Duplex fixtures are employed on this four-station machine that counterbores, undercuts and taps the centrifugal bolt hole for a screw plug

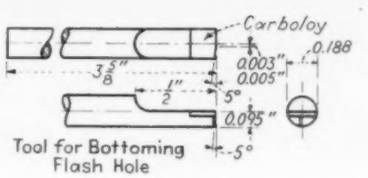


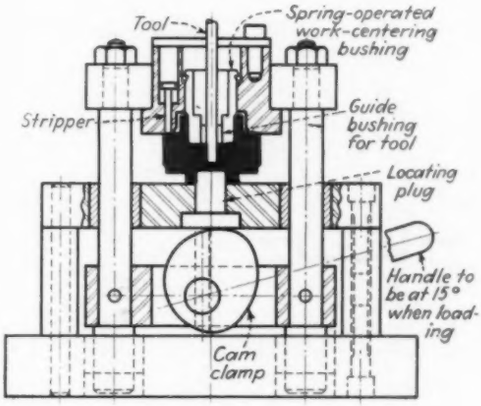


The operations on the opposite end of the body are performed on a four-spindle New Britain-Gridley. At the first working position the large end of the tapered body is turned with a form tool to make the body concentric with the die-cast bore in flight. The part is piloted in this operation. At the third spindle, a recessing attachment undercuts and faces at the bottom of the striker cover hole, and a form tool turns the outside diameter, faces the end, and turns a shoulder and recess behind the thread for the nose cap. At the fourth station, the nose-cap thread is cut.

An interesting example of secondary operations is that of drilling the two external wrench holes and coining the needle hole. The fixture involves three pillars that support the part, large end down, from the underside of the shoulder above the magazine thread. The part is correctly positioned by means of two vertical pins entering the die-cast main bore and swivel pin hole. With the piece in the fixture, the operator kicks a pedal which causes an air cylinder to clamp the part firmly in the fixture. The cylinder's piston has a tit extension that enters the needle-pin hole to coin the sharp edge and any burrs left from the machining operation on the four-spindle chucker. The two wrench holes are drilled by hand-fed opposed drilling heads, and the air pressure is released prior to removal of the part from the fixture.

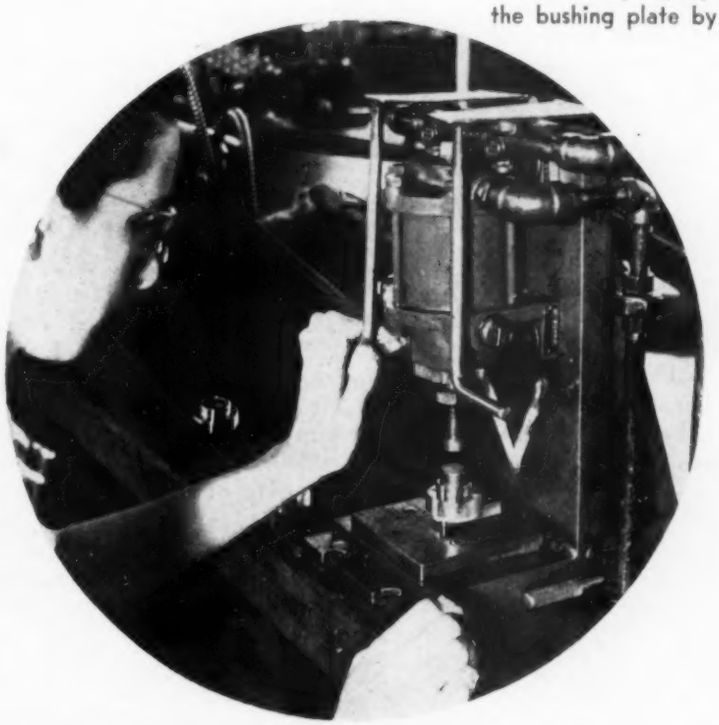
From an equipment standpoint, the operations performed upon a four-station upright machine designed by the fuze manufacturer are indicative of what can be done to combine operations and attain close limits in mass production. These operations involve production of (1) the hole for the magazine retaining screw, and (2) the tapped hole for the screw plug fitting the centrifugal bolt hole. At the first working station, the hole for the magazine-retaining screw is drilled and the





Application of motion-study principles to gaging permits the male inspector to check the fuze body at the rate of one part per minute on 32 gages arranged in a semicircle. He provides a 25 percent check on production, and is able to anticipate machining errors by an intimate knowledge of the feel of gages

Bottoming the flash hole in the die-cast magazine is an exacting operation because the distance between the bottom of the hole and the underside of the part must be 0.008 in. The magazine is laid over the locating plug and raised up tightly against the bushing plate by a cam

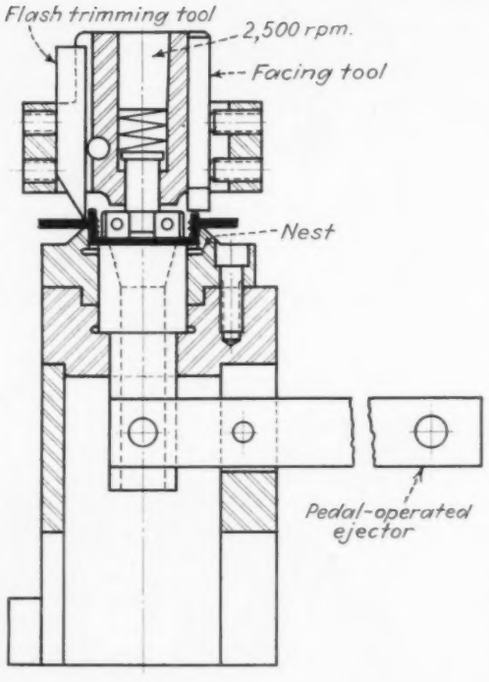


To remove the extremely sharp edge and any burrs on the mouth of the flash hole in the magazine, a coining operation is carried out with a simple fixture and air cylinder. A punch with a tit extension is placed by hand in the part, which is then positioned on a suitable fixture base. With both hands on the valve levers, the operator kicks a pedal and the piston strikes the punch a sharp blow. Chamfering of the hole is not permissible, and hence the junction of the tit and the punch body is radiused only 0.004-0.005 in. Sharp edges and tiny burrs must be avoided on holes for loading detonating charges

The operation of trimming flash and facing the rough edge of the die-cast magazine cover is so fast that the operator spends part of his time on other work. The cutting head is brought down to clamp the piece. When the head is raised, a pedal is kicked to raise the trimmed piece out of the nest

Two toolbits are mounted in the toolhead for trimming the flash and the edge of the magazine cover. Tools have large hook angles of 15-20 deg. Cutting speed is 800 ft. per min.

(Above right) Dye is applied to the centrifugal bolt by this spray painting machine. A motor-driven pawl actuates a ratchet that positions the part in front of the spray gun, which is tripped by a link connection on the pawl lever. Infra-red lamps dry the dye before the parts fall into the tote box



centrifugal bolt hole is counterbored. At the second station the bottom of the counterbore is undercut to a width of 0.040 in. At the third station, both holes are tapped. The thread for the centrifugal-plug screw may consist of only two and one-half threads (36 threads per inch). In other words, the thread length is 0.060–0.070 in., and the tap must not strike the bottom of the hole. A Dayton leadscrew-controlled tapping unit equipped with a Stearns electric brake and automatic reverse is handling this job with not more than 0.003 in. over-travel.

Inspection makes use of a novel application of motion study principles, has reduced the number of operators by one third. One of the inspector interprets limits and advises machine set-up men to make adjustments before scrap becomes a problem. The first inspector, a woman, gives one end of the machined body a close visual inspection. She passes the part to a male inspector who has 32 gages arranged in front of him in a semi-circle.

Fuze bodies passing inspection are hung on a conveyor serving an automatic degreaser and an automatic lacquer spraying machine. The part is degreased first because the residual heat retained by the metal promotes rapid drying after lacquering. The lacquering machine follows automotive practice in that a swinging spray-head operates in timed relation to work passing through the cabinet.

The advantages of die-casting as a high-production process, saving both material and operations, are also apparent in the case of the other two die-cast parts—the magazine and the bottom cover. Magazines are cast six to a gate; bottom covers four to a shot.

Drilling the flash hole in the magazine is an example of continuous development in tooling methods. The limits for the thickness of metal from the face of the flat-bottomed hole to the underside of the part have been continuously revised downward. At first, this thickness was permissible between 0.008–0.015 in. Currently the shop is working to the low limit, and tooling development is underway whereby precision boring equipment will be able to hold the metal thickness from 0.003–0.008 in., with 0.005 in. the allowable mean thickness.

Notes on Bearing Removal

Courtesy Marlin-Rockwell Corporation

MOST BALL BEARING removals are performed during the disassembly of a machine to repair or replace a broken or worn part. There also are instances where bearings must be removed before the machine has been put in operation, or to correct a defect after a running test. In each case, the methods recommended for removing ball bearings from shafts are the same. These include removal with a hammer and drift pipe, a press, or a bearing puller.

The following general precautions apply in all cases: (1) Be careful not to harm the bearing, (2) don't damage the bearing seats, (3) don't let dirt get into the bearing, (4) be sure hands and tools are clean, (5) provide clean paper on which to lay the bearing, (6) after removal, wash bearing if necessary, and (7) oil bearing and wrap in clean paper. It is more difficult to remove a bearing from the shaft than to put it on. In many cases the damage is not visible and does not show up until the unit is reassembled. Any one or all of the following can be caused by improper technique:

1. The race groove surfaces may be roughened, due to dirt or metal chips getting into the bearing during removal.

2. The smooth, polished surfaces of the race grooves may be nicked or indented by the balls, either by pulling against the outer ring or by forcing off with a hammer and chisel.

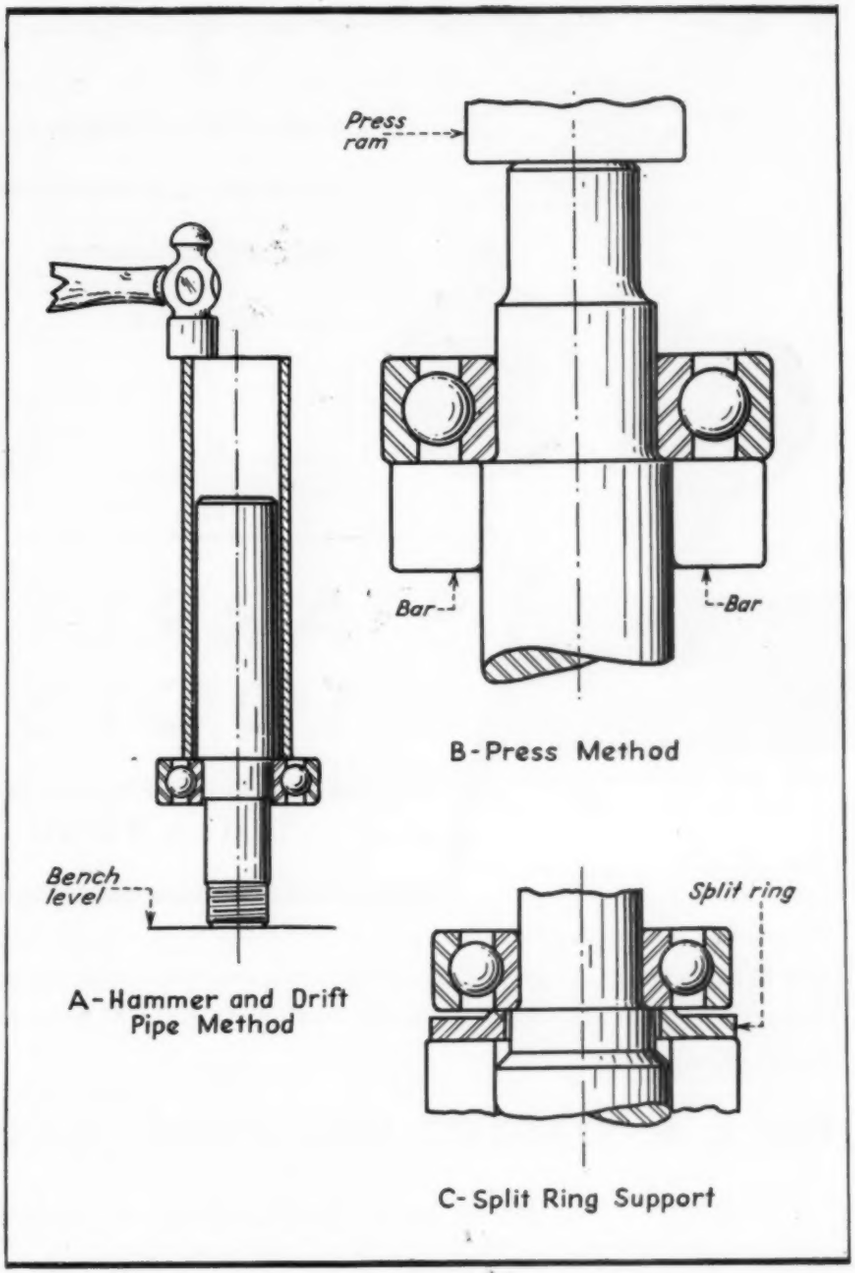
3. The ball cage may become damaged, or the rivets or fingers loosened, due to striking with a hammer or chisel.

4. A nick in the shaft shoulder or a burr on the shoulder corner will prevent the bearing seating itself firmly when replaced.

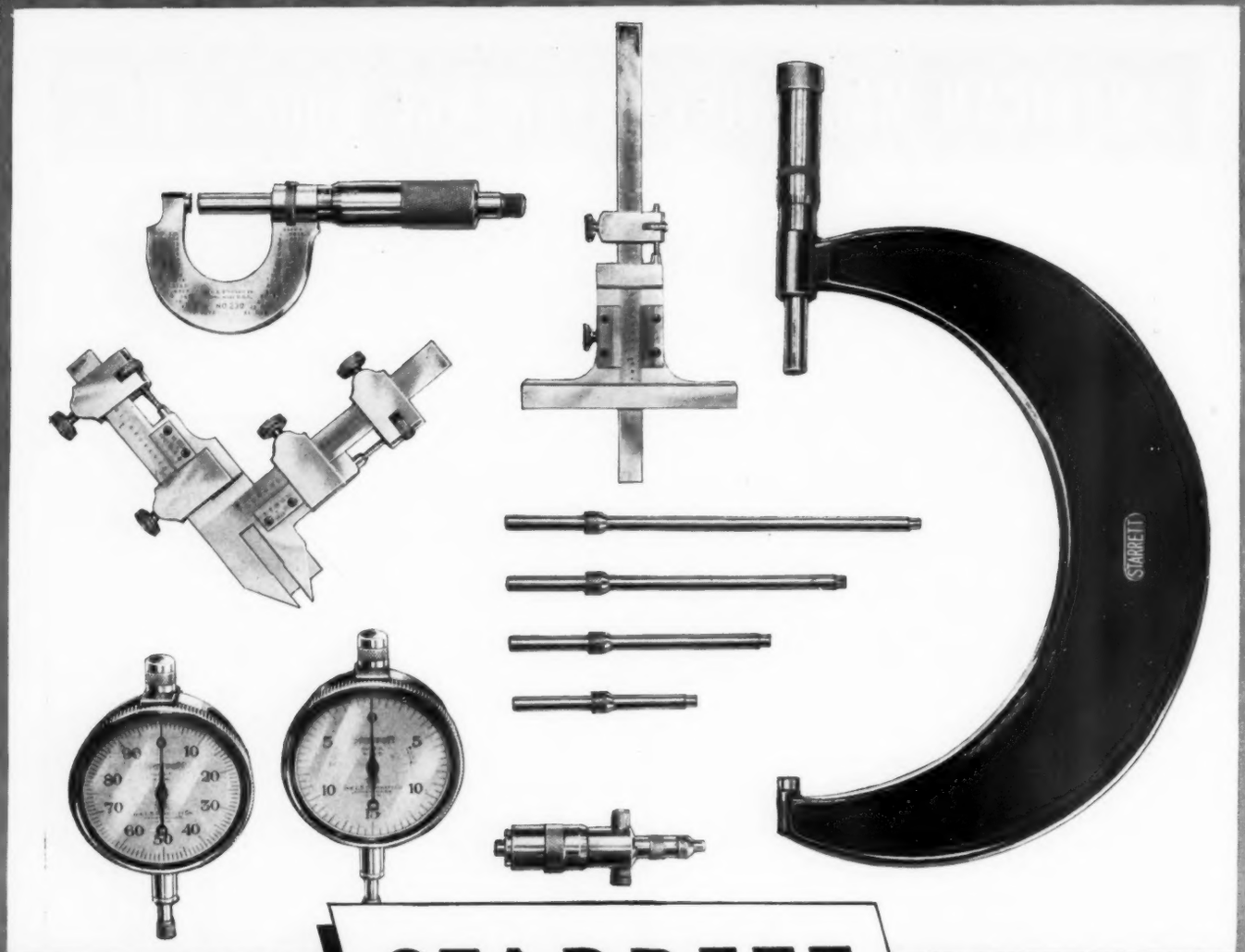
WHAT NOT TO DO

Do not use a hammer against the outer ring. Sudden blows cause the balls to damage the surfaces of the race grooves. The hammer may slip and damage the ball cage. Also, the shaft may be damaged.

Do not force the shaft out of the



Where the shaft is clear of gears or parts, the bearing can be removed with drift pipe and hammer, as at A, or pressed off with a hand press, as at B. Split rings, C, sometimes are used to support inner ring with either method. Collar on split ring must not touch outer ring of bearing



STARRETT TOOLS

Accurate-Dependable Since 1880

We pledge ourselves to protect and carry on the high standards set by our founder to the end that The L. S. Starrett Company shall continue to merit the distinction of the "World's Greatest Toolmakers" and that Starrett Tools shall continue to be known and accepted as standard for accuracy and dependability.

THE L. S. STARRETT CO., ATHOL, MASSACHUSETTS, U.S.A.

World's Greatest Toolmakers

STARRETT

PRECISION TOOLS • DIAL INDICATORS • GROUND FLAT STOCK
HACKSAWS • METAL CUTTING BANDSAWS • STEEL TAPES

Notes on Bearing Removal

bearing when supported only by the outer bearing race, unless there is no other way to remove the bearing. If absolutely necessary to use this method, be very careful to keep the pull on the outer ring square and the load steady. First, examine the bearing and see if it has deep shoulders on both sides, or one deep shoulder and one shallow shoulder. Do not apply pressure on the shallow shoulder. Ordinarily, self-aligning bearings should never be removed by pressure on the outer ring. In no case should the bearing be removed by hammering on the outer ring.

Do not use a cold chisel and hammer to free the inner ring from the shaft. This will almost always damage the shaft shoulder or the bearing seat on the shaft through cocking.

HAMMER AND DRIFT PIPE METHOD

In many cases where the shaft is clear of gears or parts, the bearing may be removed with a drift pipe and hammer. Before using pipe, clean carefully—or dirt might fall into the bearing. If the shaft has a shoulder below the bearing, rest this shoulder on the jaws of a vise. Use soft metal covering on the vise jaws. If the drift pipe will not fit over the shaft and make contact with the inner ring only, then a split washer with a raised collar should be used. Hammer blows on the drift pipe should be applied to all sides in order to drive off the bearing square.

PRESS METHOD OF BEARING REMOVAL

Where the shape and size of the shaft permits, a press often can be used to advantage to remove ball bearings. Two flat bars of equal height will be needed. These bars should be spaced so as to support both the inner and the outer ring. Some shafts have too large a shoulder to allow the bars to support the inner ring. The shoulder, however, may be such as to permit the use of a split ring to support the inner ring of the bearing.

BEARING REMOVAL WITH PULLERS

Bearings are not always easy to remove from their shafts. If they cannot be removed by the hammer and drift-pipe method, or with a press, a puller must be used. One type of puller uses a split plate, the flange of which presses against the inner ring of the bearing. The bolts must be carefully adjusted so that the pulling pressure is equal all around the ring. After the initial pressure has been applied through the puller screw, tap the opposite end of the shaft with eight hammer blows to start the bearing.

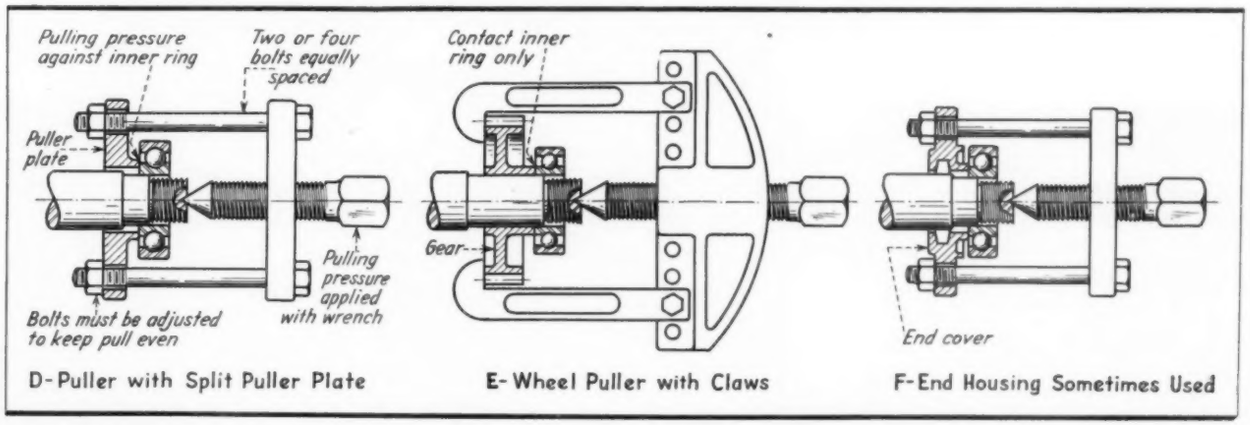
A wheel puller often can be used to pull the bearing off through an abutting gear or part. The puller claws contact the gear face and the bearing is pulled off ahead of the part. Frequently the bearing housing end cover is of such design that it can be used instead of a puller plate. Where the end cover contacts the outer ring, use a split ring between it and the bearing so pressure will be applied to the inner ring.

HEATING LARGE BEARINGS

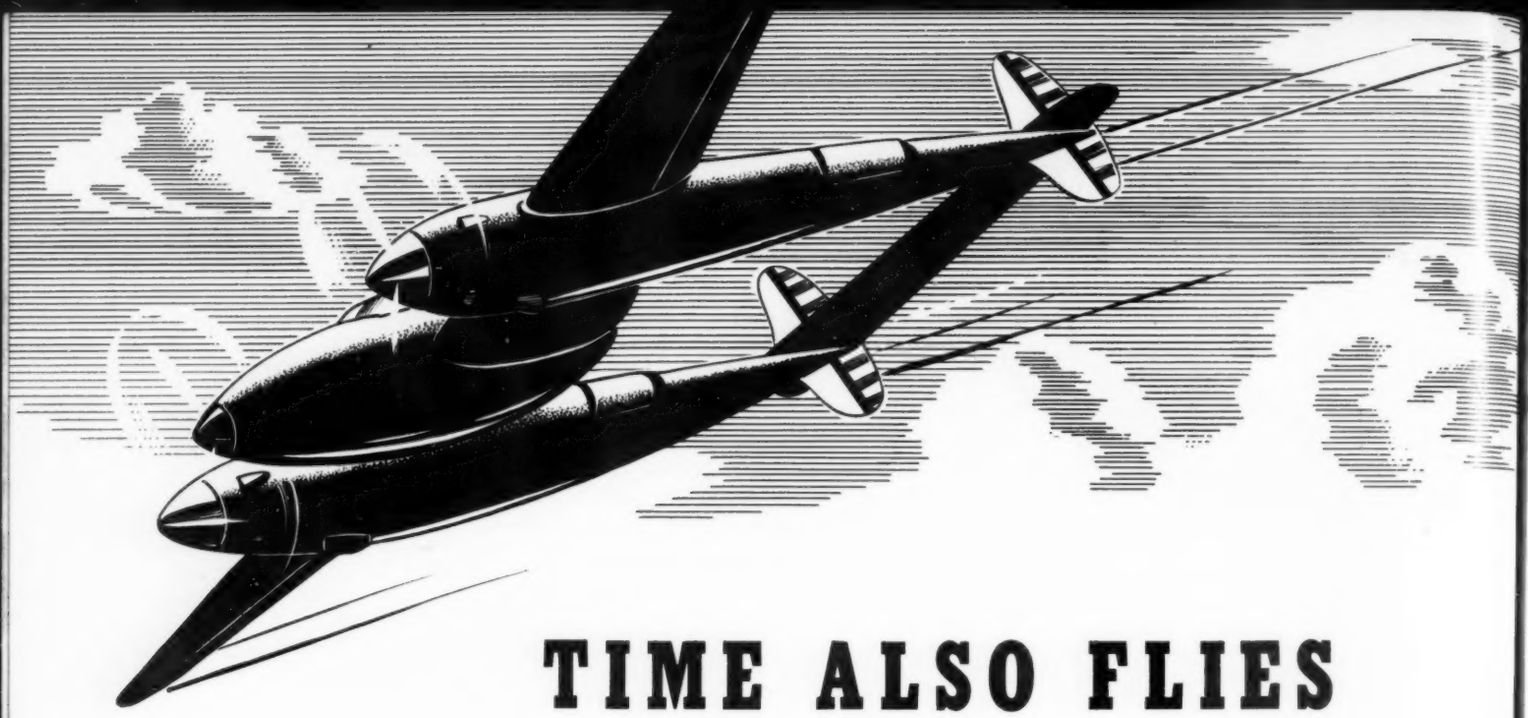
Large ball bearings sometimes are removed by heating the inner ring with a blow torch. Extreme care must be exercised if the bearing is to be used again. Slight overheating in one spot will soften and ruin the bearing.

On jobs where the bearing is being removed because performance has not been fully successful, it is desirable to find out why. Be sure to preserve the bearing as it frequently contains direct evidence of the cause of failure. It should not be permitted to rust and the parts should be abused as little as possible during disassembly.

If the bearings are being removed simply to disassemble other parts, be certain that the bearing is thoroughly washed and oiled immediately after removal. Otherwise there is a good chance that it will get dirty and rusty, thus preventing its being used. Wrap bearings in paper after cleaning.


Pulling pressure against inner ring
Two or four bolts equally spaced
Puller plate
Pulling pressure applied with wrench
Bolts must be adjusted to keep pull even
D-Puller with Split Puller Plate
Contact inner ring only
Gear
E-Wheel Puller with Claws
End cover
F-End Housing Sometimes Used

At D is shown a puller that uses a split collar puller plate having a flange to press against inner ring of bearing. Where a gear or other part is in back of the bearing, as at E, a wheel puller can be used. If end cover design permits as at F, it can be used with a puller to remove the bearing



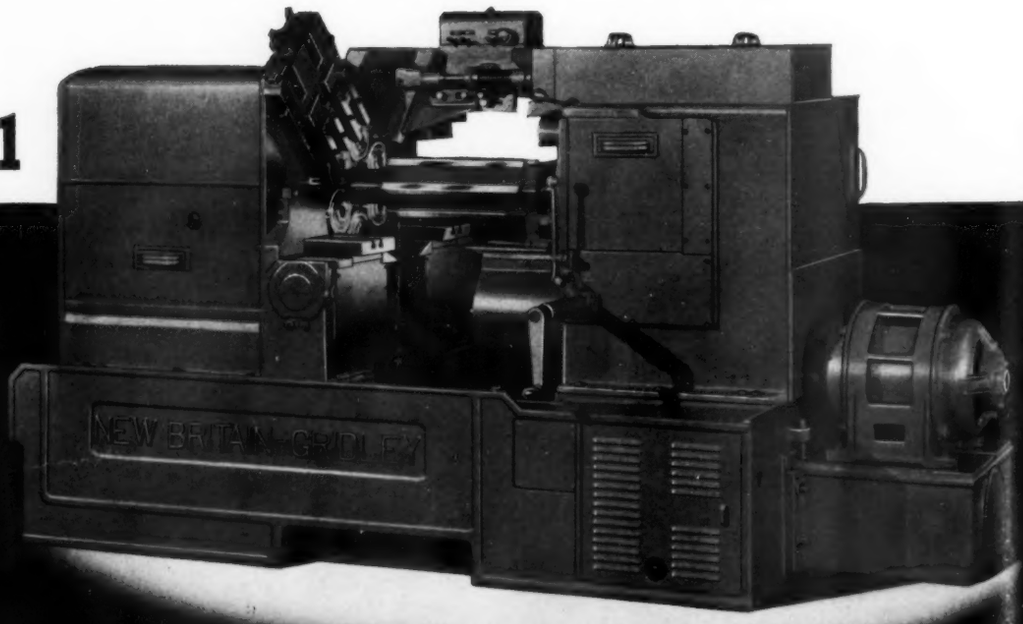
TIME ALSO FLIES

Even faster than planes. But Production is catching up with Time — helped by such machine tools as New Britain Automatics. Fast, accurate, dependable, they pile up in ever increasing quantities the materials of National Defense. *New Britain-Gridley Machine Division, The New Britain Machine Company, New Britain, Conn.*

NEW BRITAIN AUTOMATICS

Stay on the Job

MODEL 61



A complete line of Multiple Spindle Screw Machines up to 2¼" Capacity
Also a complete line of Chuckers; Four, Six and Eight Spindles up to 10¼" Capacity

On Our Way

UNFORTUNATELY for the country's morale, we have been going through a period of bitter criticism of our defense efforts.

A prominent Washington columnist refers slurringly to our "pop-gun arsenal." Senator Byrd has charged that our defense production is feeble and points out alarming figures to try to prove his point. Businesss men and some Congressmen have become irate because they see non-defense industries closing down for lack of materials and at the same time being unsuccessful in securing munitions contracts or subcontracts. Reporters who have visited our training camps have brought back stories of discontent and of exceedingly low spirts. Lend-Lease shipments have amounted to only a small percentage of the billions appropriated.

Let's admit one fact. Transforming a democracy from its peacetime habits into a war machine is a painful process. If the attempt is made in a country "short of war," as it is being made here now, the experience inevitably will be enervating and discouraging, but it also can be successful.

After a visit to Washington, we believe that the score adds up higher than the deep pessimism of many people would suggest. Our conclusions can be summed up about as follows:

The arsenal of democracy which we are feverishly building is far beyond the pop-gun stage. We shall turn out 18,000 planes this year. Tanks are coming off the line at the rate of 300 a month. Machine gun and smokeless powder production is considerably ahead of schedule. In fact, many of the government ordnance factories being erected are far in advance of the timetable laid down. The shipbuilding program is progressing better than the most hopeful expectations.

In some important defense items we are in mass production today. In others we shall be in mass production within the next two to four months.

SPAB shows signs of attacking the defense manufacturing problem realistically. The Donald Nelson-Leon Henderson combination gives promise of getting things done, using direct methods better than waiting on red tape.

Defense officials have put their finger on one of the sorest spots in the program—the hoarding of materials. They say that they will not tolerate it by private companies or by the Army and Navy; and they possess the authority to back up their orders. The faltering priorities system is about to give way to the much more effective method of allocating materials as they are needed for immediate use.

The Army and workers in defense plants are in the processs of getting acquainted with each other. We can't yet divulge the details of what is going on, but the plan now in operation is doing more than any other single thing to make factory employees conscious of their part in the program.

Morale of the draftees, and of the Army generally, passed the low point some weeks ago and has been rapidly rising ever since.

There isn't space to list other constructive factors. The main point we wish to register is that things are better than they seem. We read most of the criticisms, because they reach the front pages of the newspapers, but hear too little about the accomplishments.

Everything considered, a good job has been done thus far. Many problems still remain—subcontracting on a wider scale, keeping some civilian goods production going and speeding up the program so that no time will be lost. But in the rush to criticize, don't forget that we are much farther along than in a similar period in 1917-18. We are on our way.

Burnham Finney

GAGING BUSINESS

Tank program to be enlarged to build 3,000 a month for the British. Big bomber program to be stepped up 50 percent. September machine tool output estimated to set new record

As a result of reports from the Russo-German front, the British Government again has asked the United States to step up sharply its program for production of tanks. The British are reported to have placed tanks at the top of their list of requirements at the moment. Because of the British request, defense authorities are in the initial stages of a newly-enlarged plan for producing as soon as possible in this country 3,000 tanks a month. Two thousand of that number would be medium tanks comparable with the units now being built by Chrysler Corp. It is not expected that production on the new scale can be attained until the middle of 1942. The new program is being superimposed on a program announced recently for expanding tank manufacture greatly.

The big bomber program for the British, originally based on a production of 500 units a month, has been expanded 50 percent. The revised plan calls for tooling up U. S. industry to make 750 huge bombers every 30 days.

Machine Tools—Machine tool shipments in September are believed to have risen considerably ahead of those in August, though no official figures are yet available. August set an all-time record with production of machines totaling $64,300,000. Output that month would have been even higher were it not for the fact that workers in many plants did not wish to forego their annual vacations. It is believed that machine tool production will continue to expand the remainder of the year. The industry still is engaged in enlarging its plant capacity, in increasing the number of men on second and third shifts, in training more workers and in widening its subcontracting of defense orders. In addition, some 45 new companies have come into the machine tool manufacturing field since the start of the defense program. Orders in connection with the 500-a-month bomber program, which was announced four months ago, are just now coming through at a sizable rate. The new tank schedule, which will take a considerable number of machine tools, is still in the "talk" stage. To expedite the production of machines the full amount of money made available by the RFC for so-called pool orders is being utilized. The total is well in excess of $200,000,000. The master numerical preference list of defense customers, which instructs machine tool builders to whom machines should be delivered first, is being extensively revised. The new list will come out some time in October. Anti-aircraft gun makers and heavy bomber companies now are at the head of the list.

Aircraft—The number of U. S. planes being shipped to the British has been dropping steadily since April, when nearly 600 planes were shipped, according to reliable Washington reports. In July, the latest month for which figures are available, only 360 planes went overseas. During that period, however, the tonnage and dollar value of aircraft exported increased. What is happening, of course, is that the British want bombers and no longer are much interested in getting pursuit planes. The United States now is keeping most of its output of pursuit ships, though some are beginning to go to Russia. Almost all of the country's bomber production is being sent to Britain. As the total manufacture of planes rises, the number of planes as well as the tonnage for Britain will expand. It is unofficially estimated, in fact, that August exports were close to 500 planes. In September deliveries of light types of planes to Russia will boost the total export figure possibly as high as 700. More of the U. S. aeronautical exports are in the form of finished planes than they were last Spring. At that time large quantities of engines, propellers and parts were being shipped.

Munitions—Armament production is now rising on a 60-degree incline, which is an indication that mass manufacture of many items already is an accomplished fact. Machine guns and smokeless powder are among the products on schedule or ahead of schedule. Many ordnance plants being erected by the Government are in advance of the timetable laid down for them. To meet the greatly expanded tank program the Army has "exploded" the present tanks into 100 items. Concerns holding existing tank contracts will be asked to expedite deliveries by subcontracting as many of these items as possible. Contracts for additional quantities of tanks will stress the pooling of facilities so that a group of plants may jointly take them and be responsible for the completed units. Anti-aircraft gun production still is one of the items on which emphasis is being put to speed operations.

Steel—New orders placed by consumers have fallen off sharply. Many users have placed their requirements far ahead; others with non-defense business see little hope of getting steel unless they have priority ratings which they cannot get. Nevertheless mills are jammed with bookings. The chief fear is that the rapidly waning scrap supply available will force curtailment of production, thus hampering the defense program.

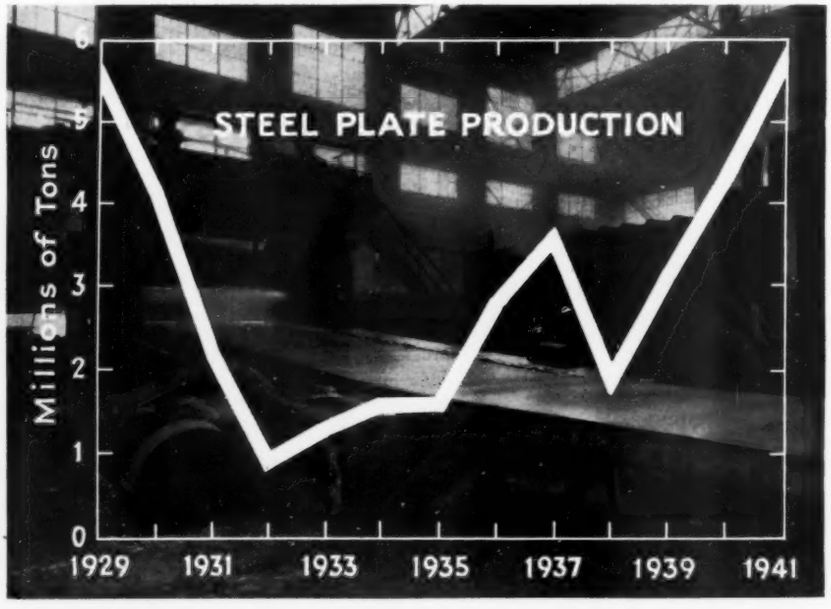


Plate Shortage—*Steel plates get scarcer and scarcer, as production heads toward record of 5,800,000 tons for the year. Capacity is around 6,000,000 tons, nearest previous approach was 5,734,000 tons in 1918. Most plates go for ships and tanks. As programs get into full swing, even more will be taken for these purposes. Railroad car makers get plates next, but not as much as they need. Other users take what is left, far less than orders*

Lend-Lease Shipments Low Now, Will Rise; British Cash & Carry Purchases High, to Fall

WASHINGTON—A lot of rather unjustifiable dismay is being expressed over the low figures on lease-lend aid to Britain revealed in the President's report to Congress last month. The figures are certainly low, expenditures totaling about $390,000,000, actual exports only $190,000,000. Most people appear not to realize that lease-lend still represents only a small fraction of physical aid to Britain. Thus, during the period since the passage of the lease-lend act, exports to the British Empire and Egypt have totalled nearly a billion and a quarter. Since the beginning of the war, the figure is four and a half billion.

The point is that Britain has enough dollar credits to pay off contracts placed in this country before lease-lend. Most current deliveries are being applied against these contracts. It is only when the British contracts run out that lease-lend figures will assume significance.

What lease-lend expenditures there have been are mostly in fields in which the British did not place large contracts last year—$110,000,000 for food, $109,000,000 for ships. Contracts totalling more than three and a half billions have been placed from lease-lend funds, ready to take up the slack when the British orders run out. Nearly all of the original seven-billion appropriation has been allocated to specific projects.

Lend-Lease for New Projects

The President's request for another six billion for lend-lease is made not because he is afraid the original money will run out but because he wants to get started on new projects not covered in the first sum. Thus the administration now expects to feed Britain, and $1,875,000,000 is asked for this, nearly double the amount in the first appropriation. The aircraft program is now pretty well lined up. New money for this drops to a comparatively small half billion. Ordnance, at $1,190,000,000, ships at $850,000,000, tanks and other vehicles at $385,000,000 are at much the same levels as in the first request. For new productive facilities, $375,000,000 is asked.

More than half of the $65,380,000 allotted to machine tools from the first appropriation is now under contract, with contracts totalling $38,100,000. At first sight it seems rather remarkable that this much has been contracted for, in view of the amount of red tape that a lease-lend tool order has to go through. One tool builder says the negotiation period has been lengthened from four days, when he was dealing direct with the British, to four months now.

The necessity of presidential signature has often been one of the bottlenecks, but the President has now given power of attorney on this to Lend-Lease Administrator Stettinius.

SPAB ALLOWS ALL REPAIRS

WASHINGTON—In return for a priority order, making maintenance and repair parts available to all industries, the Supply, Priorities and Allocations Board expects an industry wide pledge to hold inventories at a minimum working level, to conserve critical materials and to extend simplification and substitution. Under the previous Office of Production Management order, about 22 industries were covered. SPAB's extension order applies to all defense and non-defense activities.

Allocations Will Replace Inadequate Priority System

WASHINGTON—Allocations of materials are about to take the place of priorities as SPAB gets into action. In fact, priorities will fade out of the picture for all practical purposes, because they have fallen into a mess. They simply haven't worked. That has been particularly true since early August.

Defense officials have the real facts about how much material is being used and how much is being stored. Too much of it is being hoarded, in their opinion. They know, for instance, that only 22,000 tons of copper were fabricated into defense articles in the entire month of July. They know that a single civilian goods producer has huge quantities of aluminum.

Will Publicize Hoarders

How will hoarders be punished? Within two weeks it is likely that several flagrant cases will be publicized by the government. Such publicity is expected to stop most of the worst offenders. Allocations of materials will take into account the stocks on hand. So long as private companies or government agencies, including the Army and Navy, have excess stocks on hand, they are going to find it extremely hard to get new deliveries.

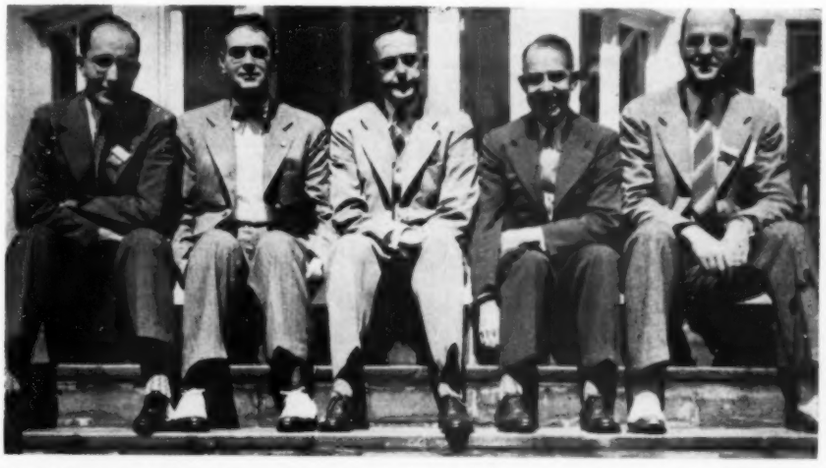
SPAB has the necessary authority to see that the service branches get only what they can use within a reasonable length of time. And it intends to exert that authority.

SPAB's plan for spreading the existing stocks of materials and the supplies yet to be produced are counted on to relieve some of the shortages now existing. Nevertheless, the months immediately ahead will be the toughest many lines have ever experienced.

TOOL SHIPMENTS SET RECORD

CLEVELAND—August shipments of machine tools amounting to $64,300,000 were the highest in the history of the industry, according to the National Machine Tool Builders Association. Previous peak was $63,400,000 in June. July shipments dropped to $57,900,009, due largely to vacation periods. Rearrangement of production schedules also contributed to the decline.

August shipments were 57.6 per cent greater than those in August, 1940. For the first eight months of this year, shipments amounted to $470,100,000 compared with $251,500,000 in the similar period of 1940. This is an increase of over 85 per cent.



Machine Tool Dealers—*Members of the Associated Machine Tool Dealers of America gathered at The Homestead, Hot Springs, Va., for their annual meeting Sept. 12–13. Left to right: Thomas A. Fernley, Jr., executive secretary of the association; Albert M. Stedfast, first vice-president; Fred B. Scott, Jr., president; L. H. Pratt, second vice-president; and Robert Giebel, director*

Ford Takes Over Large Part of 30-Ton Tank Expansion

DETROIT—Reports from Washington that Ford will become the largest supplier of 30-ton tanks, and probably also build 60-ton tanks, should occasion no surprise in view of the exceptional interest in tanks displayed by the British during their recent visit to the Chrysler Tank Arsenal. Ford is now building a 350,000 sq. ft. steel foundry to house four Bessemer converters and six electric furnaces.

Output of this foundry will supply cast-steel cylinder liners for the Ford-built Pratt & Whitney engines and landing gears, and will probably be a source of tank castings. The Rouge plant has been qualified as a producer of armor plate and armor castings. Considerable space exists for tank fabricating and assembly, although it will probably be necessary to erect additional structures.

General Motors is admittedly working upon a tank project, and has developed diesel-type tank engines. Local sources indicate that Cadillac will take general responsibility for GM tank production, with parts to be made by various divisions. It is probable that GM has developed its own tank design in collaboration with the Army. A new tank drive of the "Hydramatic" type has been developed. Said to weigh 3,000 lb. instead of 8,000 lb. and to save room and weight. This can be used for additional ammunition and fuel. The new drive, also, provides greater manoeuverability for the vehicle.

Since the automotive industry is essentially set up to produce "horsepower," the expectation is that additional orders will break soon for mobile units—motorized gun mounts and even armored trains. It is not improbable that the country will eventually possess armored trains for transporting supplies of ammunition and fuel which will have terrific fire power.

A recent conception of these armored trains includes a tractor with 1,000-hp. motor, an ammunition wagon, supply wagons and forts incorporating as many as three 5-in. guns. Turtle-like in appearance, these mobile forts would be part of a train extending over 300 ft. long. Obviously many components in this fearful conception of modern warfare are "meat" for the automobile industry.

FEWER TRUCKS ORDERED

CHICAGO—Orders for electric industrial trucks during August amounted to 227 units, worth $745,599, according to the Industrial Truck Statistical Association. This total compares with 273 units booked in July at a value of $1,059,093. Included in August orders were 30 non-elevating platform trucks, 155 cantilever trucks, 13 tractors, 10 crane trucks and one special scoop shovel truck.

Investigation of Excess Profits May Lead To 7 or 6 Per Cent Limitation on Contracts

WASHINGTON—House Naval Affairs Committee's investigation of the defense program, with special reference to excess profits, is going ahead via a vast number of questionnaires to manufacturers. The questionnaires, in 13 categories for aircraft builders, ordnance manufacturers, shipbuilders, etc., have brought in a substantial proportion of answers so far. Numbers 12 and 13 apply to ordnance.

Unconfirmed reports, at this writing, indicate that the Committee headed by Carl Vinson, of Georgia, is already drafting legislation which will impose a seven percent profit ceiling on all defense contract profits. No hearings have been held as yet, and the Committee's information is based solely on the answers to questionnaires, and whatever it may have gleaned on the side.

Toland Counsels Committee

Counsel to the Vinson Committee is E. M. Toland, the attorney who won fame by serving the "Smith Committee" which investigated the Labor Relations Board months ago. At that time, Mr. Toland glorified business as the victim of the Board, but that seems to have no bearing on his present job of ferreting out profiteers. Mr. Toland probably will have little difficulty in exposing some startling examples of gold rolling. Many contracts have been literally forced upon industry since the Nazi conquests; no doubt some contractors played safe with wide cost margins, which the government did not or could not check.

It should be understood that the Vinson investigation covers the whole of industry, including all munitions and war supply manufacturers, not only for Navy but for the Army, Maritime, etc. Treasury Secretary Morgenthau supports Vinsons anticipated recommendation of a seven percent limit with a recommendation of his own: He would limit war contract profits to six percent and take all the rest with a hundred percent tax. The present tax law suspended all the previous profit limitations on Naval ships and on Army and Navy airplanes and some merchant ship subcontracts, substituting the present excess profits tax, which takes a maximum of 73 percent.

Most business men do not like the excess profits tax, because it is wellnigh beyond comprehension; and they don't like the profit limitation proposals. Both, they say, are dampers on initiative. Only one thing is certain about the Vinson investigation: nothing will come of it for some time.

MACHINERY EXPORTS FALL

WASHINGTON—Exports of industrial machinery declined two per cent from June to $27,794,765 in July. Only metal-working machinery declined, with machine tools being exported at a volume of $9,226,262 compared with $11,233,804 in June.

Exports of Machinery During July, 1941

	July 1941	June 1941	July 1940
Electrical machinery and apparatus	$8,618,728	$8,733,635	$8,890,619
Power-generating machinery, except electric and automotive	2,625,982	2,586,486	1,522,951
Construction and conveying machinery	3,290,620	2,615,313	2,352,152
Mining, well and pumping machinery	2,961,543	2,429,269	4,746,107
Power-driven metal-working machinery	10,559,688	12,103,426	14,906,312
Other metal-working machinery	946,314	1,448,794	582,087

Metal-Working Machinery

Engine lathes	440,533	527,812	727,930
Turret lathes	872,880	1,063,191	1,019,565
Other lathes	416,914	673,668	629,638
Vertical boring mills and chucking machines	1,054,917	440,257	307,944
Thread-cutting and automatic screw machines	769,433	1,462,095	523,749
Knee and column type milling machines	446,744	768,474	587,325
Other milling machines	1,287,859	1,338,533	1,315,960
Gear-cutting machines	152,903	367,202	484,344
Vertical drilling machines	165,223	87,559	142,756
Radial drilling machines	25,075	36,048	206,836
Other drilling machines	338,466	220,484	494,947
Planers and shapers	111,055	146,864	855,283
Surface grinding machines	314,164	257,571	167,122
External cylindrical grinding machines	123,544	384,598	399,939
Internal grinding machines	129,390	114,725	485,327
Tool grinding, cutter grinding and universal grinding machines	307,372	464,994	354,798
Other metal grinding machines and parts	294,466	213,328	909,175
Forging machinery and parts	719,161	696,247	337,997
Rolling-mill machinery and parts	456,542	441,544	1,006,770
Molding machines	21,633	13,435	221,124
Other foundry equipment parts	124,235	218,925	90,159
Other power-driven metal-working machinery and parts	1,005,783	1,507,920	1,976,694
Pneumatic portable tools	121,287	122,434	102,356
Other portable and hand or foot-operated metal-working machines and parts	155,486	167,879	147,000
Chucks for machine tools	74,352	67,946	70,488
Milling cutters, machine-operated threading dies and taps, and similar machine-operated metal cutting tools	246,780	562,349	107,030
Other metal-working machine tools and parts	348,409	528,186	155,213
Sheet and plate metal-working machines and parts	650,128	621,226	1,850,366

Amortization Law a Failure, Faces Change; Propose Extending Time Limit to 6 Months

WASHINGTON—The tax amortization law over which Congress sweated for three months last summer has been an almost complete failure. It was designed to encourage private investment in defense plants. As it turns out the overwhelming proportion of plant expansion has been government financed.

The law—Title III of the Second Revenue Act of 1940—permits manufacturers who install new facilities necessary for defense to deduct from their net taxable income, each year for five years, one fifth of the cost of the new facilities. That is, for tax purposes, he may amortize his plant in five years.

However, defense officials and congressmen who feared a wholesale giving away of plants by the government imposed a condition upon this privilege. If the manufacturer has been reimbursed directly or indirectly by the government for the cost of new facilities, he may take advantage of the rapid amortization privilege only if the equity of the government in his plant is protected. This must be certified to by both the Defense Commission and the Army or Navy.

This obscure proviso has enmeshed the whole subject in red tape, but confusion has not actually retarded much plant investment. Industry in the main just isn't interested in putting its own money into the munitions business on any terms. Confusion has created a blinding headache for those firms which do have their own money tied up in defense plants.

Would Remove Worst Troubles

Now pending in Congress is a bill amending the tax law to remove some of the worst troubles. It would extend to six months from start of construction on new facilities the time within which application can be made for amortization privileges; present limit is sixty days. The short time now allowed means that applications must be filed on the basis of preliminary plans; and every time the plans change, the application must be amended.

The proposed legislation would exempt small contracts from the non-reimbursement proviso, eliminating vexing details. The Army has had to approve non-reimbursement certificates on contracts as small as 60¢. Subcontractors, having no contractual relations with the government, are not reimbursed and consequently don't have to obtain certificates of non-reimbursement. If, however, a manufacturer has expanded his plant to take on defense subcontracts, and then gets even a tiny prime contract, rapid amortization privileges on the entire facilities are jeopardized.

Most important of all, the new law would entrust enforcement of this proviso to the Army and Navy alone, eliminating the Defense Commission (statutory duties of the practically extinct defense commission are now being handled by the Tax Certification Unit of the Office for Emergency Management).

To appreciate the importance of this last change, it is necessary to recall present procedures. The legislation provided for the use of three certificates. The manufacturer first obtains a Certificate of Necessity saying that his plant is needed for defense. If he is not being reimbursed, he must obtain a Certificate of Non-reimbursement saying so. If he is, he secures a Certificate of Government Protection saying that the equity of the government is protected. Each certificate has to be signed by the Army or Navy and by the Defense Commission.

Actual Contract Had to Exist

Trouble came with the second certificate. For months Army and Navy maintained that a contractor was not being reimbursed for his plant unless there existed an actual reimbursement contract, such as an Emergency Plant Facilities agreement. Defense Commission argued that an actual investigation must be made of the price of munitions manufactured in the new facilities to determine whether the price included more than normal allowance for plant cost. It was an impasse, for six months the applications piled up, hardly a certificate was issued.

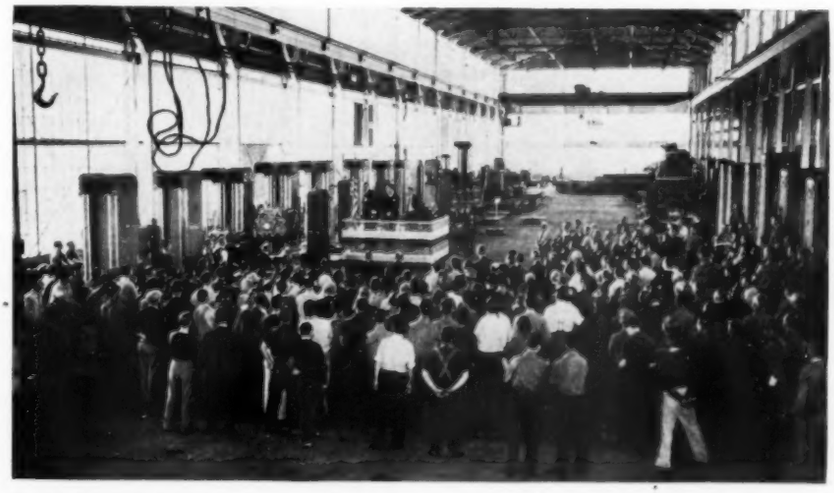
Last May, as reported in *American Machinist*, Army and Navy accepted the Defense Commission position—in principle. It looked as if the jam was broken. Both services set up tax amortization units (Army has more than 60 people working on the job), started to work out procedures for the examination of contracts and for some time have been processing applications at a good rate.

In practice, however, it hasn't worked out. The Commission has not agreed with Army and Navy methods of determining whether contract price includes plant reimbursement, thus holding up many certificates. The situation is well illustrated by the figures on Army contracts. The War Department has received some 1,800 applications for Non Reimbursement Certificates. Of these it has approved and turned over to the Commission nearly 1,500; the Commission, has approved only 115, has rejected 182, and has the remaining 1,200 pending.

Price Control Bill Coming, Lacks Authority Over Wages

WASHINGTON—Price control legislation appears a certainty, though it may be weeks or even a month or two before a bill reaches the President's desk. It's a touchy subject that will have long hearings and long Senatorial debate. But the administration is determined to have the bill, and the impression in Washington is that the Congressmen came back from their vacation convinced that there's a popular mandate for legislation.

The bill now before the House Committee on Banking, may have reached the floor of the House by the time you read this. It would authorize the President to fix ceilings for the price of any commodity and for rentals; he would be forbidden, however, to fix agricultural prices below 110 percent of parity or wage rates. In setting ceilings, the President is to be guided by prices prevailing July 29, 1941.



Tool Expansion—*First machine completed in the new machine tool plant of Chambersburg Engineering Co. is started by Captain E. D. Almy, U.S.N., at dedication ceremonies Sept. 19. Under a Navy subcontract with William Sellers & Co., Philadelphia, Pa., horizontal boring, drilling and milling machines will be made in the new 300 x 87 ft. building. Bay is 90 x 60 ft.*

Armor Use on Aircraft, Tanks Increases; Plate Thickness Compromised With Weight

WASHINGTON — For thousands of years people have crouched behind metal plate to keep from being speared or shot by other people. They have been taking cover behind steel armor for nearly 200 years. In today's wars, a score or more armor applications protect life and the vitals of fighting machinery. You find plate on war ships, self-propelled artilery, gasoline supply tanks, personnel cars, trucks and scout cars. Of course armor is a specialty with the new armored divisions, who ride and fight aboard their weapons—tanks. Many guns carry steel shields to protect operators. Even helmets are made of armor steel.

Latest application of armor plate is on aircraft. It began during the World War when pilots sat on stove lids to avoid getting rifle balls in the seats of their pants. Some ordnance offices worked on airplane armor at that time, but during the peace years nothing was done. In World War II, first the Germans and then British began using airplane armor extensively.

Fly Even Though Hit

Skeleton-like airframes can fly away even though punctured by hundreds of small bullets, but crew and vital parts, such as gas tanks, electrical and hydraulic gear and controls are vulnerable. These are protected by armor. A hit by any kind of explosive shell from .50 cal. up is likely to disable the ship and/or the crew, and there is no help for it. But armor does stop most bullets up to .50 cal. and flying fragments of shell.

Attack from air-borne guns comes mostly from the rear hemisphere, between 15° below to 45° above level. Therefore, the best protection is placed behind the pilot and vital plane parts. The attacked airplane has the advantage of distance, usually more than 100 yards from the enemy, and the plane speed relative to the bullet speed, causes wide dispersion of the hits; and most shots come from an angle, which weakens the hits. Anti-aircraft shell fire, coming from below, accounts for only a minor portion of casualties.

Airplane armor plate ½ in. thick stops a .50 cal. bullet at angles of 65° or less; ¼ in. plate stops a .50 cal. bullet if obliquity is 20° or less. Main resistant factors are thickness of plate, ballistic properties of the metal and impact angle. At normal angles the impact is on an area about three times the diameter of the projectile, thus concentrates a high stress on the plate. A glancing impact stresses a much greater area and, thus, is less effective. For example, bullets striking plane wings at angles near zero, are deflected by very thin armor.

2 Types of Plane Armor

There are two types of airplane armor: face hardened and homogenous. Face-hardened armor, as the name implies, is tough and hard on the exposed side. Being soft on the inside, it does not throw "buttons" when struck by a bullet. Homogenous armor is consistently hard and compact throughout. It throws buttons. On the other hand it can be formed in contours and heat treatment is simple. Special shapes in plate, such as curves, blisters, pyramids, to angle bullets, all promise good results and are being tried. Springs and rubber bases have been tried under the plate, without success.

Of course armor is not the plane's only protection; parts of the ship itself are placed and designed with protection in mind. Discs of the tracted wheels can be placed to fend bullets from gas tanks or other vitals. In fact the whole machine may be designed with an eye to "tumbling" the bullets, reducing their impact.

Tanks Also a Problem

Tanks are next to planes in newness of the armor problem. Of the slow (three to five m.p.h.) behemoths of the World War the Russian tanks had the thickest armor: 5 in. maximum, used only at some points. The Germans, U. S. and British just over 1 in. thick and the French 2 in. Brigadier General G. M. Barnes, Assistant Chief of Ordnance, points out that the ideal armor would be so thick that it would resist all manner of shot. But weight of plate must compromise with lightness of tank for speed and maneuverability. Armor, unfortunately, is the greatest weight producing factor in the machine.

Three types of plate are used in tanks:

(1) Rolled face-hardened plate, is most common at present. This type gives the greatest protection against bullets up to .50 caliber. But it is brittle, and does not stand up under the shock of hits by larger projectiles. It is used on light tanks, because it is the only thin plate which will keep out the slugs of high-powered machine guns. It can be welded and formed without difficulty.

Plate Absorbs Shock

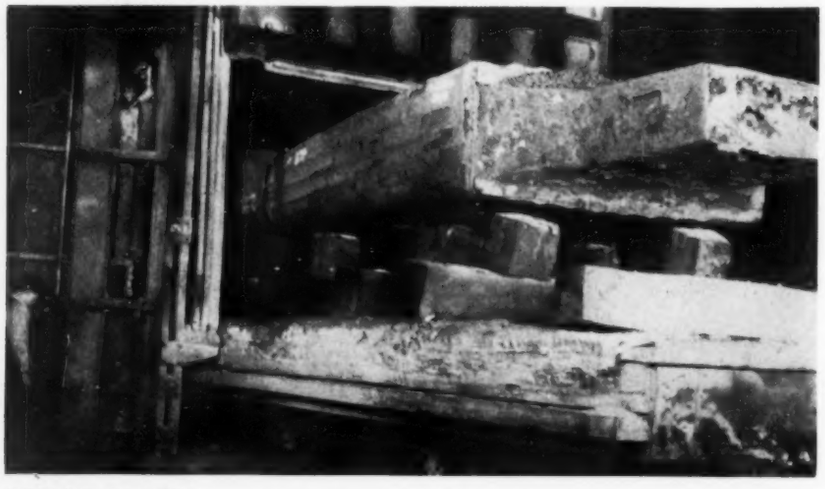
(2) Rolled homogenous plate affords the best ballistic values against projectiles larger than machine gun bullets. It also, absorbs the shock of cannon fire.

(3) Cast armor, much discussed of late, is increasing in use. Up to now it has been made to give 90% of the ballistic value of rolled homogenous plate. The important advantage in cast plate is that it can be formed in any of the shapes that offer oblique surfaces to projectiles.

Flushhead counter sunk riveting, long used, is not entirely satisfactory for fabricating tanks. Projectile hits snap rivets and heads. This trouble has been lessened by recent practice of button-head riveting without countersinking. Nevertheless, Gen. Barnes says that welding, which has been under experiment since 1923, soon will be extensively used.

The trend is toward thicker armor. But the designer runs into diminishing returns because as the added weight slows tanks, so that he must add more engine, more space, until the light tank is a medium, a medium a heavy, etc., with loss of desired agility.

Several dozen companies are manufacturing armor plate for the Army and Navy. Increasing restrictions make it impossible to tell from the records which firms are making how much of what.



ARMOR PLATE—*From this ingot entering a heating furnace heavy steel armor plate for a battleship will be forged. Armor, also is used extensively in aircraft and tanks. Expanded ship, tank and plane programs have called for more and more armor of better grade and lighter weight.*

INSIDE DETROIT

Decision to arm merchant ships finds Pontiac, Hudson ready to supply thousands of Oerlikon anti-aircraft guns. Suggest two substitutes for priorities. Tolan group hears hoarding denial

BY RUPERT LEGRAND, DETROIT EDITOR

DETROIT—The President's decision to arm merchant vessels finds two automobile companies—Hudson and Pontiac—well along on independent programs to manufacture Oerlikon 20-mm. rapid-fire cannon by the thousands in 1942. This gun, mounted in numbers from one to twenty on various types of vessels, throws up a hail of high-explosive shell against dive bomber attacks.

Stukas must come down to 2000 ft for effective bombing, but the Oerlikon throws shell to 5,000 ft. A gunner can get in 175 shots while the target is within range. Each shell will tear a hole a foot or more in diameter in a plane's skin. Even though a lucky hit is not made in a vulnerable spot, three or four explosions in wings or fuselage will be sufficient for wind pressure to tear the plane apart.

These characteristics of the Oerlikon have shoved it into the limelight as one of the most important procurement problems. Pontiac's original order was trebled when the Navy saw the progress being made upon tooling-up an existing 365,000 sq. ft. building. Successful testing of the first pilot guns in August was the signal to double the second order. Newspapers have estimated that Pontiac's orders now equal approximately $75,000,000, but reliable information suggests that this figure is far too low.

Pontiac Building Plant

Pontiac's six-fold increase in Oerlikon orders has prompted breaking ground for a new plant of 307,000 sq. ft. All equipment has been ordered. Steel will be on hand by Nov. 1. The building will be up by Dec. 1 and ready for tools and machinery by Jan. 1. Production will commence by Feb. 1. Employment eventually will reach a total of 5,000 men working three shifts per day, six days per week.

Meanwhile, gun manufacture is ahead of schedule in the original plant. In October, a status of "50 percent balanced machine tool equipment" will be reached. Out of 195 parts in the gun, 175 are being made by 41 sub-contractors. Gun barrel and breech mechanism are produced by Pontiac, and the entire gun assembled there. More than 5,000 tools, jigs and fixtures coming from 152 suppliers, and machine tools from 50 manufacturers are required.

Hudson is rushing machinery installation in its Oerlikon building, one of fourteen in the $20,000,000 Naval Ordnance plant. Production of gun parts is moving forward and a sizeable force will be at work in November. By Feb. 1, Hudson expects to have the entire arsenal functioning on a wide variety of Navy materiel, including fire-control equipment and components of large guns. It should be noted that Hudson converted the original metric drawings of the Oerlikon gun to inch measure, and has supplied copies to the Pontiac, the other independent prime contractor.

Use New Broach

Contemplated production of Oerlikons in the thousands per month rather than hundreds is predicated upon the use of high-production machinery where possible. Pontiac, for example, will use a new broaching method developed by American Broach Company, whereby the time of rifling a 70 in. barrel is cut from approximately 3½ hr. to 10 minutes. Pull broaching is done in four passes. No. 1 broach cuts one-quarter of the width of each of nine grooves, and leaves a few thousandths in the bottom for finishing. No. 2 cuts the same amount of stock, a ribbon on each side of the first cut, and No. 3 does likewise after the second cut. The fourth broach finishes the width and bottom.

Head rotates according to a fixed spiral lead, and the first broach is fitted with a spiral bar that maintains the tool in the correct lead and eases the cutting load. Subsequent broaches follow the original lead and have the spiral ground in them. Detachable shanks are used with the tools so that only a 48 in. length need be mounted between centers for conventional face grinding. Broaching is done under oil pressure, the tool being sealed in an oil tube. American Broach's experimental machine went to the Flannery Bolt Co., Bridgeville, Pa., for producing Oerlikon barrels for the British, because of the urgent need. Pontiac has received the first production machines.

Big Companies Hard Hit

Vociferous complaints have been made by thousands of small plants against the priorities system on the ground that they are being or will be forced out of business. The problem is just as pressing to volume producers, like auto plants, because they consume a great variety of materials. Orderly scheduling of materials flow (the secret of success in the industry) is impossible. Priorities, unfortunately, consider individual materials, whereas the defense and the civilian manufacturer must plan for a project that may call for many materials. If one is lacking, the whole enterprise is blocked.

In the opinion of automotive per-

BIRD GUNS—*Serious lack of anti-aircraft guns will soon be filled. Hudson and Pontiac expect to turn out Oerlikon 20 mm. rapid fire cannon by the thousands. Recently the first 90 mm. gun made by private industry was completed (above). Oerlikon is used against low flying and dive bombers*

sonnel, wrestling with priorities questions, two courses might be more desirable: (1) an allocation system, such as used by the British and Germans, or (2) normal, pre-priority methods of procuring materials providing excess stocks are liquidated. Unfortunately for the second proposition, materials have been partially fabricated in many instances so that they can be used only for the original purpose—egg beaters or munitions many months from now.

No Hoarding By Auto Makers

Before the Tolan Congressional Committee investigating national-defense migration, auto spokesmen flatly denied that the industry has been hoarding materials. It is known that one of the larger interests is striving to bring its supplies back to normal (that is, in relation to curtailment) as fast as possible. Not anticipating an early slash in production, this company is caught with excess stocks. The company normally buys fabricated parts 30 days ahead of use, and raw materials 60 days ahead to allow time for fabrication and movement through the various stages to the assembly line. This policy will be maintained for several reasons: what is good for the country, is good for the auto company, there is not adequate storage space for hoarding, and it is dangerous to accumulate excessive stocks when all auto production might be suspended or the possibility that the war might end suddenly.

In speaking before the Tolan Committee, C. E. Wilson, president of General Motors, stated that: GM did not foresee the extent of the present slash in auto production, particularly the extra heavy cut given the corporation because it is "big," he did not think the slash necessary, there is a bad misalignment in the flow of materials. So far as he knows, no one in authority has appraised the over-all needs for materials in defense, and he suggested a study of the flow of materials. Mr. Wilson also stated that defense requirements are not so tremendous as people think. The corporation, according to Mr. Wilson, has followed a conservative policy in laying in materials and may be caught short on certain items. Little if any copper will be received in the fall months, a fact that can cause greater curtailment than that ordered by government if the situation does not mend.

Production of passenger cars for December is limited to 204,848 units, or a total of 1,023,217 for the five months ending Dec. 31. The cut for December amounts to 48.4 percent as compared to December 1940. The total for the five months is 32.2 percent below that in the similar period a year ago.

Limitation order L-4 provides that the producer of replacement parts for passenger cars and light trucks may make from Sept. 15 to Dec. 31, 60 percent of the number of replacement parts sold for civilian purposes during the first six months of 1941.

Canada Produces 40 Planes Per Week, Will Fill Own Propeller, Instrument Requirements

MONTREAL—Canadian aircraft production, which before the war was less than one unit per week, has reached the rate of 40 per week. During this two year period, number of workers in the industry has increased from 2,270 to 28,750. Twelve types of planes are being made but it is planned soon to concentrate production on six types. These will be an elementary trainer, a single engine advance trainer, a twin-engined advance trainer, a coastal reconnaissance amphibian, a bomber and a fighter. Current orders total 7,000 planes of which 1,000 have been ordered from U. S.

Dependency on Great Britain and the U. S. for propellers and instruments is decreasing. Within a year, Canada will be producing all her instrument needs and enough propellers to provide a surplus for export to Britain. All hope of building engines has been abandoned. They will continue to be imported from the U. S.

Set up of four new branches in the Department of Munitions and Supply to expand administrative control, indicates that Canadian war industries have graduated from the development stage into the large scale business class. Aim of the new branches, covering guns and tanks, ammunition, munitions contracts and industrial planning and engineering, is to speed further increases in production and to assure future expansions to meet changing needs.

To Put Idle Plants to Work

Another new division, a "bits and pieces" branch, has been established to spread war contracts so as to make full use of idle plants, machinery and men. In a recent survey of 5,283 parts, the Canadian Manufacturers Association found that, among 51,000 of 61,000 machine tools reported on, there was a cumulative daily idleness of 700,000 hours. Of course not all of this idle capacity can be utilized. In many cases tools are used part-time on certain work and can not be reset economically for other work. Others are not of a type that can be used on war work.

Some form of labor conscription may soon be instituted. Addition of 40,000 new recruits into Canadian army and industry each month has seriously drained man-power reserves. Persons not now employed, including married women, will be called and there will be some switch of personnel from peace-time industries to war work. Twenty-five percent of the production force at one plant making war equipment are women. By December this company expects to double its personnel and to employ 70 percent women.

Labor troubles, as well as shortage, have become more serious. McKinnon Industries, Ltd., is closed by a strike which threatens to tie up production of military machines at automobile plants. Like the coal production slow-up in Nova Scotia, this strike is a protest against the government wage policy, allowing only cost of living bonuses and keeping a ceiling on wage rates.

Strikes Due to CIO

Much of the recent strike difficulty has been due to CIO organizers, who before the war were unable to get a foothold in Canadian industry. Now most of the war workers are CIO organized. Older unions, formerly in the dominant position, have asked the government to oust "foreign" labor unions. In a recent public opinion poll 59.7 percent of the people polled declared emphatically that the government should prevent strikes during the war. Another 23.5 percent asked for prevention without emphasizing their position. At present all disputes must be referred to a conciliation board before a strike can be legal. Furthermore, no strike can be called unless a majority of workers vote for a strike in a ballot taken by government officers.

Recent contracts awarded by the Department of Munitions and Supply included: for shipbuilding, $170,000 to Grew Boats, Ltd., Penetanguishene, Ont. and $4,147,200 to Port Arthur Shipbuilding Co., Port Arthur, Ont.; for land transport, $178,200 to Metallic Roofing Co., Ltd., Toronto, $235,859 to Ford Motor Co., Windsor, Ont. and $640,440 to Ford Motor Co., Windsor; for aircraft, $1,152,576 to Dowty Equipment, Ltd., Montreal and $525,474 to MacDonald Bros. Aircraft, Ltd., Winnipeg; for ordnance, $513,000 to Dominion Bridge Co., Lachine, Que., $799,476 to Ford Motor Co., Windsor and $308,812 to Engineering Products, Ltd., Montreal.

50 Prime War Orders Grow Into 9,974 Subcontracts

WASHINGTON—Announcement that 50 recent War Department prime contracts, totaling $271,651,962 were subcontracted to the amount of $163,538,719 or 60.2 percent indicates that the drive to spread defense contracts over the entire country is beginning to take effect. The department's Contract Distribution Division in cooperation with the Office of Production Management were instrumental in the letting of 9,974 subcontracts in these prime contracts.

In the survey of contracts where subcontracts amounted to 40 percent or more, the Army found that $98,519,010 out of $151,677,397 let for tanks and combat vehicles was subcontracted. This amounts to 65 percent. Other subcontracting percentages were artillery, 54.2 percent; small arms, 56.6 percent and ammunition, 54.5 percent.

WATCHING WASHINGTON

Navy's 1,900 ton armed cargo vessels expected to play important part in aid to anti-Nazis. Plans expansion of steel by decreasing number of specifications. Manufacturers warned to ask for ratings

BY BLAINE STUBBLEFIELD

WASHINGTON—Biggest news of the fortnight in the Allied-Axis battle for the Atlantic is the Navy's projected series of "Sea Otter" 1900-ton cargo ships. Navy expects that a large flotilla of these light freighters will be afloat within a year. President Roosevelt himself gave "active and insistent help" to the project. Some think he had a hand in the design. He certainly passed the job to the Navy, somewhat to the embarrassment of the Maritime Commission, which was already irked by recent charges of over-conservatism and lack of imagination.

First full-sized test vessel, Sea Otter No. 2, designed by Weaver, Inc., was built by Livingston Shipbuilding Company, both of Orange, Texas. Sea Otter No. 1 was a one-third scale model for tests, built by Jacobson Shipyards of Long Island. The Otter is armed with a "suitable" anti-aircraft gun, which can be used when the neutrality law is repealed, or the ships can be transferred to other than U.S. registry. The ship is light, simple in construction, cheap in first cost and upkeep and can be built in two months.

Propulsion is by sixteen 110 hp. gasoline engines geared to a single propeller. *American Machinist* is told that the engines probably are V-8 marine conversions of regular automobile motors. This means that they are jacketed and piped with brass to resist salt water. How the engines are geared is not told, but it is known that they drive a vertical shaft geared to a six-foot propeller underneath and amidships, no doubt in a channel, to give shallow draft. The boats are only 270 feet long and can be floated to sea on rivers and canals from inland production centers. Speed is 12 knots, and cruising range 7000 nautical miles.

The propelling mechanism can be hoisted and replaced while the ship is under way. The entire stearing gear, which is hand powered, seems to be above deck, where any breakdown can be repaired. Unit losses of these ships would be relatively small, in capacity, cargo and crew. It would take many submarines to take much of a toll on swarms of them at sea.

Boosting Steel Production

Production of steel, especially alloy steel, will be increased appreciably during the war with existing facilities by concentrating on a minimum number of specifications, compositions, sizes and shapes. At the request of OPM the American Society for Testing Materials, Society of Automotive Engineers and the Iron and Steel Institute, collaborating with Army and Navy is forming an Administrative Committee to work direct with advisers from other interested organizations.

Committee is headed by C. L. Warwick, OPM consultant, and secretary-treasurer of ASTM. Objective is to establish a selected list of steel specifications to be called National Emergency Steel Specifications. Consideration will of course be given to non-defense requirements. The list will be used as an aid to administration of steel priorities and allocations.

Meanwhile, Priorities Director Nelson amended steel order M-21 with a provision that directions may be issued to any producer as to deliveries he may make or the kinds of alloys he may produce.

Must Seek Priority Rating

Some manufacturers of non-munitions equipment recently have been so confused and preoccupied that they have neglected to obtain the materials preference ratings to which they are entitled, thus working a hardship on their customers. To remedy this situation, for example, mining concerns have contacted suppliers of machinery, acquainting them with their needs and urging them to go to the Priorities Division with a PD-1 application. Municipal governments, wanting snow plows, bull-dozers, shovels and the like, are being urged by priority specialists in Washington to let their suppliers know what they need, and to assist them in preparing applications for ratings.

TO BUY MORE METAL GOODS

WASHINGTON—About half of the President's recent request to Congress for $5,985,000,000 to augment the lend-lease program will be allocated to metal-working firms. A breakdown of the appropriation shows: $685,000,000 for aircraft including engines, parts and accessories; $850,000,000 for the construction and equipage of ships and other water craft; $385,000,000 for tanks and other land transport; $155,000,000 for miscellaneous military and naval equipment and material; and $1,190,000,000 is set aside for ordnance including armor and ammunition.

More Ships on Way to Sea

Saturday, September 27, "Liberty Fleet" day, saw the launching of 14 ships of the Maritime Commission's construction program. This was not only the largest launching since the

"OTTER" BRIDGE FOR ATLANTIC—*"Sea Otters", 1,900 ton armed navy cargo ships like the model above, will soon enter the Battle of the Atlantic*

World War, but it marked the beginning of mass production of shipping for anti-Axis forces. By early next year, yards will be turning out an average of two ships a day, 600 ships a year, or about 4,300,000 gross tons.

Our merchant ship program now totals about 12,000,000 gross tons, which is twice as much as the total built during the 20 years following the World War. Liberty Fleet day, also, saw the beginning of the Navy's program of merchant Sea Otters, 1,900-ton cargo vessels which will swarm the oceans if they are as successful as now indicated.

The Commission's current progress report shows that of the total 788 vessels ordered for all purposes, 104 were completed as of September 1. It reports that 34 keels of the EC-2 emergency design have been laid, first three of which were launched last Saturday.

Manufacturers Fight Threat Of Community Hiring Halls

DETROIT—In the wake of the agreement reached between government, labor and the auto industry concerning seniority rules to govern the shift of workers from non-defense to defense tasks, has come the threat of community hiring halls. In brief, laid-off workers would register with local agency offices and be sent out at call from defense manufacturers.

Manufacturers, objecting on several grounds, would like to see the plan squelched. First, the transition to defense jobs may take as much as nine months for thousands of men. Only false hopes of employment would be raised. Second, the manufacturer would lose control over the hiring process. Third, shop stewards in the defense plant could easily make complaints about new men which the United Automobile Workers (CIO) would take up with the agency. In a short time, the agency would be subject to union domination, regardless of intentions. Fourth, the plan would extend the union's influence immensely. If abused, it could easily mean that a potential defense worker would have to be a union man to get a job. In other words the community hiring hall might become a potent organizing center.

Manufacturers prefer to protect their people by offering older men opportunities on defense jobs, or by advising them that a layoff threatens. Under the new seniority rules, men leaving non-defense jobs to take defense employment elsewhere retain their seniority in the original plant. While this policy threatens to disrupt organizations, the manufacturers feel that they owe whatever assistance can be given to the older men, who have greater responsibilities. By this handling of the situation, defense jobs could be filled as available because employment managers in a community could easily interchange information on prospects.

U. S. Government Contracts Awarded to Metal-Working Firms

(Does not include contracts under $160,000)

Source	Agency	Commodity	Amount
Vultee Aircraft, Inc., Downey, Calif.	War	Airplanes, engines, propellers	$12,384,083
Emerson Electric Mfg. Co., St. Louis, Mo.	"	Turrets	8,025,000
Blackhawk Mfg. Co., Milwaukee, Wis.	"	Jacks	554,484
Northrop Aircraft, Inc., Hawthorne, Calif.	"	Airplanes, parts	18,411,812
Fairchild Engine and Airplane Corp., Farmingdale, N. Y.	"	Engines, parts	2,494,964
Kohler Co., Kohler, Wis.	"	Shell	1,750,000
Waterbury Clock Co., Waterbury, Conn.	"	Fuze bodies	970,000
Boeing Aircraft Co., Seattle, Wash.	"	Maintenance parts	172,267
Shephard Niles Crane & Hoist Corp., Montour Falls, N. Y.	"	Electric hoists	198,000
Pump Engineering Service Corp., Cleveland, Ohio.	"	Vacuum pumps	161,450
Edwards Mfg. Co., Cincinnati, Ohio.	"	Steel boxes	254,160
Mesta Machine Co., Pittsburgh, Pa.	"	Forgings	199,525
Morse Tool Co., Inc., Detroit, Mich.	"	Cutters, reamers	328,686
Robertshaw Thermostat Co., Youngwood, Pa.	"	Boosters	895,923
Borg-Warner Corp., Rockford, Ill.	"	Magazines	251,100
Wackman Welded Ware Co., St. Louis, Mo.	"	Drums	279,400
Thompson Pipe & Steel Co., Denver, Colo.	Int.	Penstocks, pipe	214,610
Blaw-Knox Co., Pittsburgh, Pa.	TVA	Tunnel forms	256,630
The Draper Mfg. Co., Cleveland, Ohio.	War	Drums	238,050
Servel Inc., Evansville, Ind.	"	Cartridge cases	797,297
Noblitt-Sparks Industries Inc., Columbus, Ind.	"	Bombs	731,921
General Motors Corp., Guide Lamp Div., Anderson, Ind.	"	Cartridge cases	2,450,000
Warren Webster & Co., Camden, N. J.	"	Ammunition, boosters	320,000
Bay Products Corp., Newton, Mass.	"	Carbon removing tools	219,002
American Bridge Co., Pittsburgh, Pa.	Int.	Steel towers	1,400,378
R. Wallace & Sons Mfg. Co., Wallingford, Conn.	War	Cartridge clips	980,400
The Crosley Corp., Cincinnati, Ohio.	"	Bomb shackles	729,995
Revere Copper & Brass Inc., New York, N. Y.	"	Brass sheets	349,376
Aluminum Co. of America, Washington, D. C.	"	Rivets	431,085
The Denison Engineering Co., Columbus, Ohio.	"	Hydraulic testers	616,737
John A. Roebling Sons Co., Trenton, N. J.	Maritime	Cargo handling appliances	163,161
International Harvester Export Co., Chicago, Ill.	Treas	Tractors	507,989
Ralph B. Carter Co., Mansfield, Ohio; Trenton, N. J.; and Philadelphia, Pa.	"	Pumps	544,300
S. Morgan Smith Co., York, Pa.	TVA	Turbines	217,675
The Baldwin Locomotive Works, Eddystone, Pa.	"	"	757,820
Otis Elevator Co., Washington, D. C.	Treas	Elevators	184,883
Guiberson Diesel Engine Co., Chicago, Ill.	War	Engines	335,889
Dowty Equipment Corp., Long Island City, N. Y.	"	Pumps	759,200
Independent Pneumatic Tool Co., Chicago, Ill.	"	Compression riveters	197,150
Caterpillar Tractor Co., Washington, D. C.	"	Tractors	371,710
Caterpillar Tractor Co., Washington, D. C.	"	"	327,678
Allis-Chalmers Mfg. Co., Knoxville, Tenn.	TVA	Generators	727,812
Teletype Corp., Chicago, Ill.	War	Teletype sets	3,013,947
General Cable Corp., New York, N. Y.	Int.	Copper conductor	229,809
Westinghouse Electric & Mfg. Co., Knoxville, Tenn.	TVA	Generators	627,157
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.	War	Radio transmitters	348,588
Ford Motor Co., Dearborn, Mich.	"	Trucks	2,273,395
Bell Aircraft Corp., Buffalo, N. Y.	"	Airplanes	75,218,384
Douglas Aircraft Co. Inc., Santa Monica, Calif.	"	"	176,316,690
The Autocar Co., Ardmore, Pa.	"	Tractor-trucks	277,875
General Electric Co., Schenectady, N. Y.	"	Radio equipment	14,669,142
Belmont Radio Corp., Chicago, Ill.	"	"	2,106,758
Hickok Electrical Instrument Co., Cleveland, Ohio	"	Indicators, thermometers	658,590
Mullins Mfg. Co., Salem, Ohio.	"	Shell	697,493
Ohio Steel Foundry Co., Detroit, Mich.	"	Helmets	767,985
Brown & Sharpe Mfg. Co., Providence, R. I.	"	Grinding machines	719,325
The Midvale Co., Philadelphia, Pa.	"	Tubes	864,000
U. S. Pipe and Foundry Co., Birmingham, Ala.	"	Shell	694,572
Chrysler Corp., Detroit, Mich.	"	Trucks, parts	238,513
Bauer Brothers Co., Springfield, Ohio.	"	Shell	1,930,500
Sheffield Steel Corp., Kansas City, Mo.	"	Forgings	600,000
Vimalert Co., Ltd., Jersey City, N. J.	"	Engine parts	461,219
Bay Products Corp., Newton, Mass.	"	Carbon removing tools	219,002
Axelson Mfg. Co., St. Louis, Mo.	"	Forgings	370,900
Axelson Mfg. Co., St. Louis, Mo.	"	"	384,000
General Motors Corp., Indianapolis, Ind.	"	Engines, parts	8,501,605
Fargo Motor Corp., Detroit, Mich.	"	Trucks, ½-ton	2,809,561
Highway Trailer Co., Edgerton, Wis.	"	Semi-trailers	553,383
Yellow Truck and Coach Mfg., Pontiac, Mich.	"	Trucks, 2½-ton	4,016,562
Rheem Mfg. Co., New Orleans, La.	"	Shell	1,034,250
Thibodaux Boiler Works, Thibodaux, La.	"	"	900,000
Minneapolis Moline Power Implement Co., Minneapolis, Minn.	"	"	2,335,755
The Murray Co., Atlanta, Ga.	"	Lathes	458,502
Harnischfeger Corp., Milwaukee, Wis.	"	Diesel shovels	163,037
Radiart Corp., Cleveland, Ohio.	"	Fuzes	1,610,350
General Motors Corp., Chevrolet Motors Div., Baltimore, Md.	"	Trucks	160,472
Mesta Machine Co., West Homestead, Pa.	"	Boring Mills	323,600
United States Rubber Co., New York, N. Y.	"	Cable assemblies, reels	388,465
Widin Metal Goods Co., Garwood, N. J.	"	Mast bases	300,995
Rauland Corp., Chicago, Ill.	"	Transmitting equipment	498,355
Philco Corp., Philadelphia, Pa.	"	Remote controls	163,848
Eicor, Inc., Chicago, Ill.	"	Dynamotors	172,486
Majestic Radio & Television Corp., Chicago, Ill.	"	Radios	322,754
Graybar Electric Co. Inc., New York, N. Y.	"	Telephone cable, reels	317,382
Oliver Farm Equipment Co., Chicago, Ill.	"	Shell	2,832,732
R. Wallace & Sons Mfg. Co., Wallingford, Conn.	"	Cartridge Clips	980,400
The Ainsworth Mfg. Corp., Detroit, Mich.	"	Bomb shackles	197,673
Brewster Aeronautical Corp., Long Island, N. Y.	"	Gas tanks	163,136
Vega Airplane Co., Burbank, Calif.	"	Airplanes, parts	147,790
Leece-Neville Co., Cleveland, Ohio.	"	Parts	313,091
The C. H. Gosiger Co., Dayton, Ohio.	"	Drill presses	211,900
Bendix Aviation Corp., South Bend, Ind.	"	Carburetors, parts	466,168
American Gas Accumulator Co., Elizabeth, N. J.	"	Lighting Trucks	346,330
General Bronze Corp., Long Island City, N. Y.	"	Propeller dollies	269,100
Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.	"	Forgings	260,000
The Murray Co., Atlanta, Ga.	"	Shell	162,000
The Murray Co., Atlanta, Ga.	"	"	162,000
International Machine Tool Corp., Indianapolis, Ind.	"	Turret lathe equipment	432,008
The Broderick Co., Muncie, Ind.	"	Shell	1,690,000

Republic V-Pres.

O. W. WINTER

Engineering Heads at Bell

GEORGE CARSON and ROBERT L. STEVENS

Sales Manager

COOLIDGE SHERMAN

No Lease-Lend Yet to Reds Who Want Materials, Tools

WASHINGTON—Aid to Russia is still being handled outside Lease-Lend the President is anxious to have the Soviet included in the pending Lease-Lend appropriation, in order to prevent a morale sapping slap. In the last couple of weeks some $20,000,000 has been made available to Russia, half as a treasury loan and half as an advance on reconstruction finance corporation purchase of strategic materials.

What the Reds most want to buy are raw materials and tools. They have asked for large quantities of machine tools and aluminum to replace destroyed production capacity. A moderate number of tools have been allocated, but it is doubtful that they can get much aluminum. Neither U. S. nor Britain has much to spare.

REGULATE GEARMOTORS

WILKINSBURG—A new standard output speed program for gearmotors has been adopted by the American Gear Manufacturers Association to conform with the desires of OPM and other defense agencies that industrial specifications be simplified. The standard adopted uses a 1,750 r.p.m. base with a series factor of 1.225. This means that the next lower speed is found by dividing 1,750 by 1.225. This result is in turn divided by 1.225 to find the next lower speed and so on. Gearmotor users are expected to benefit from standardized products, from reduced inventory of parts and from better deliveries.

NAMES in the NEWS

O. W. Winter has become vice-president in charge of manufacturing, Republic Drill & Tool Co., Chicago, Ill., newly organized manufacturers of high speed twist drills. For the past four years he has served as factory manager, Columbus McKinnon Chain Corp., Tonawanda, N. Y. His previous business connections included Cincinnati Milling Machine and Cincinnati Grinders, Inc., Kent-Owens Machine Co., Toledo, Ohio, and Whitman & Barnes, Inc., Detroit, Mich. He also served for a time as consultant to the Soviet Machine Tool and Cutting Tool Trusts in the U.S.S.R. He is a vice-president, American Society of Tool Engineers.

Robert L. Stevens, assistant works manager, has been appointed plant engineer, Bell Aircraft Corp., Buffalo, N. Y. He will be assisted by George Carson. Mr. Stevens had previously been plant engineer for power plant and machine tool companies in the West. Mr. Carson has been a tool and die maker and designer.

J. L. Goddard, formerly with the Goodyear Tire & Rubber Co. of Calif., has been appointed manager of the recently created industrial relations department, Plomb Tool Co., Los Angeles, Calif.

Lawrence K. Blackman, assistant treasurer, has retired from active service after 43 years service with the Farrel-Birmingham Co., Inc., Buffalo, N. Y.

Kenneth R. Blake has been appointed chief engineer, The Kaydon Engineering Corp., Muskegon, Mich. Among others he has served Bendix-Stromberg Carburetor Co., Eaton Mfg. Co. and Muncie Gear Mfg. Co.

D. B. Colyer, former vice president of Trans-Canada Airlines, has been appointed special representative of Canadian Steel Controller to the United States. His duties at Washington will be to cooperate with U. S. authorities in respect to the Dominion's steel requirements.

Coolidge Sherman has been appointed Eastern Sales Manager, Allegheny Ludlum Steel Corp., Pittsburgh, Pa. He had been manager of valve steel sales and previously was assistant to the president of the old Ludlum Steel Co.

George Gilman has become chief engineer of the Thomas B. Gibbs Co., Delavan, Wis. He had been with Gilman Engineering Works, Janesville, Wis.

J. Hugo Smith, founder of the Wesson Co., Detroit, Mich., is retiring as president of the company.

W. G. Prasse, formerly eastern representative, has been made sales manager, The Oil Gear Co., Milwaukee, Wis.

Leigh E. St. John has been promoted to the position of plant engineer, International Business Machines Corp., Endicott, N. Y. Joining the company in 1932, he had been assistant plant engineer. At the same time Samuel E. Lenox was made supervisor of the planning department, Earl F. Gilliam was appointed supervisor of inspection and Walter H. Blake became foreman of the sub-assembly and unit inspection department.

Ray P. Tennes has been elected chairman of the board of directors, Shafer Bearing Corp., Chicago, Ill., to succeed his father, the late M. J. Tennes. He will continue as treasurer.

Dean R. Wilson was appointed purchasing agent, Warren, Ohio, plant, Copperweld Steel Co. Among his previous positions were vice-president, Carbon Steel Co., and president, Anchor Drawn Steel Co.

In announcing recently the appointment of Russell G. Davis as manager of the Commercial Gear Plant, Chicago,

Ill., American Machinist omitted the fact that this plant is owned by Foote Bros. Gear & Machine Corp.

PLANT EXPANSION

American Machine & Metals, Inc., New York, N. Y., has been granted a $240,000 loan from the Reconstruction Finance Corp. to be used in the purchase of new machinery and equipment.

The Defense Plant Corporation, a subsidiary of the Reconstruction Finance Corporation, has authorized the following lease agreements for plant expansion:

W. F. and John Barnes Co., Rockford, Ill., $2,000,000.

The Bullard Co., Bridgeport, Conn., $300,000.

Douglas Aircraft Co. Inc., Santa Monica, Calif., $522,170.

Eaton Mfg. Co., Saginaw, Mich., $116,583.

Eaton Mfg. Co., Battle Creek, Mich., $173,950.

Eureka Vacuum Cleaner Co., Detroit, Mich., $103,017.

General Electric Co., Erie, Pa., $6,763,580.

Hanson-Whitney Machine Co., Hartford, Conn., $325,000.

Holley Carburetor Co., Detroit, Mich., $661,415.

Hyatt Bearings Div., General Motors Corp., Harrison, N. J., $567,000.

Pullman Standard Car Mfg. Co., Chicago, Ill., $285,152.

A. O. Smith Corp., Milwaukee, Wis., $505,301.

The Warner & Swasey Co., Cleveland, Ohio, $550,000.

Weatherhead Co., Cleveland, Ohio, $1,018,200.

National Supply Co., Torrance, Calif., is spending $2,000,000 to expand its facilities for the manufacture of shafts and other forgings for U. S. Navy and Maritime Commission Ships.

Westinghouse Electric & Mfg. Co., will spend $1,800,000 to expand its Sharon, Pa., works. The new construction will provide transformer tank and structural iron shops, an office building and laboratory.

BUSINESS ITEMS

Allison Div., General Motors Corp., Indianapolis, Ind., has opened a district office in Buffalo, N. Y., to serve as a contact point with plane manufacturers. Harley Hicks has been named manager.

Bell & Gossett Co., 5000 Wallace St., Chicago, Ill., will move Oct. 15 into a new factory at Morton Grove, Illinois.

The Bristol Co., Waterbury, Conn., has transferred H. R. Bristol of the engineering and sales departments to their Boston office. J. E. Booth will take over Mr. Bristol's territory in the Chicago district.

Carnegie-Illinois Steel Corp., Pittsburgh, Pa. has appointed William G. Crook, assistant manager of sales in charge of the Buffalo, N. Y., office. Paul F. Vander Lippe was appointed assistant to the manager of sales in charge of the Kansas City, Mo., office. They replace Charles E. McIntyre and Howard J. Mullin, respectively, who were recently transferred to the Detroit office.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., have appointed Harry G. Johnson as sales representative in the Indianapolis, Ind., territory. He replaces Gerald Beebe, who is on leave of absence due to illness.

McKenna Metals Co., Latrobe, Pa., have made B. E. Middleton representative in the Central New York territory with headquarters at Rochester. He had been Chicago representative.

Norton Company, Worcester, Mass., has appointed R. J. Forkey sales manager for northern and western New York.

Stearman Aircraft Div., Wichita, Kansas has been renamed the Wichita Div., Boeing Airplane Co.

OBITUARIES

ROBERT V. GOOD

Robert V. Good, 50, manager of the Philadelphia Works, General Electric Co. since 1936, died Sept. 17 in Drexel Hill, Pa. After graduating from the Royal Technical School, Stuttgart, Germany in 1911, he came to the United States. He joined the General Electric Co. in 1913. In 1928 he became superintendent of the milling department and a year later was transferred to Philadelphia as assistant works manager.

Harold Osborne, 57, general manager and assistant vice president of the United Shoe Machinery Corp., Boston, died recently in Swampscott, Mass.

L. H. Morrison, 59, editor of *Diesel Power* and former associate editor of *Power*, died of a heart attack Sept. 20 in Port Washington, N. Y. He belonged to the American Society of Mechanical Engineers and Society of Automotive Engineers and authored several textbooks including "Oil Engines" and "American Diesel."

Hugh A. Scallen, 46, district manager for the New England branch of the Jessop Steel Co., Hartford, Conn., died of a heart attack Sept. 2. He had been associated with the tool steel industry for 23 years.

Harold J. Stein, 47, director of research, chemistry and metallurgy, Allis-Chalmers Mfg. Co., Milwaukee, Wis., died Sept. 9. Joining the company as a student apprentice in 1916, he served in turn as general foreman of the heat treating operations, assistant foreman of the forge department, research engineer and chief research engineer of all manufacturing departments. In 1939 he took over the direction of the research, chemistry and metallurgy activities when they were consolidated into one department.

MEETINGS

American Gear Manufacturers Association. Semi-annual meeting. Edgewater Beach Hotel, Chicago, Ill., Oct. 20–22.

American Society for Metals. Twenty-third National Metal Congress and Exposition. Convention Hall and Commercial Museum, Philadelphia, Pa. Oct. 20-24.

American Society of Mechanical Engineers. Fall meeting. Louisville, Ky., Oct. 12-15.

American Society of Tool Engineers. Semi-annual meeting. Royal York Hotel, Toronto, Canada, Oct. 16-18.

American Welding Society. Annual meeting and convention. Bellevue Stratford Hotel, Philadelphia, Pa., Oct. 19-24.

Electro-Chemical Society, Inc. Annual Meeting. Hotel Knickerbocker, Chicago, Ill., Oct. 1-4.

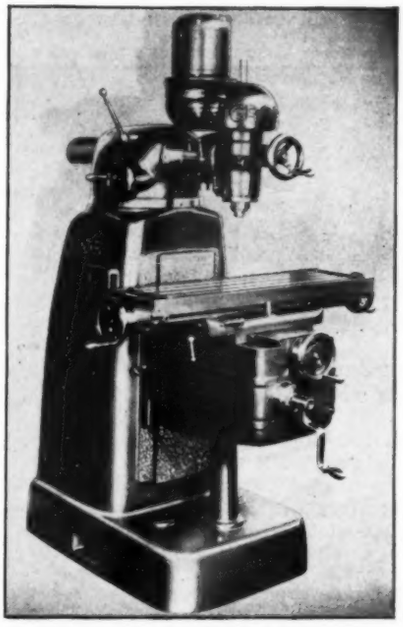
Exposition of Power and Mechanical Engineering. International Amphitheater, Chicago, Ill., Oct. 6-11.

National Safety Council. National Safety Congress and Exposition. Chicago, Ill. Oct. 6–10.

Society of Automotive Engineers. National Aircraft Production meeting. Biltmore Hotel, Los Angeles, Calif., Oct. 30-Nov. 1.

SHOP EQUIPMENT NEWS

Spindle on Cross Miller Adjusts to Any Angle In Any Plane; Overarm Extends Head 12 In.



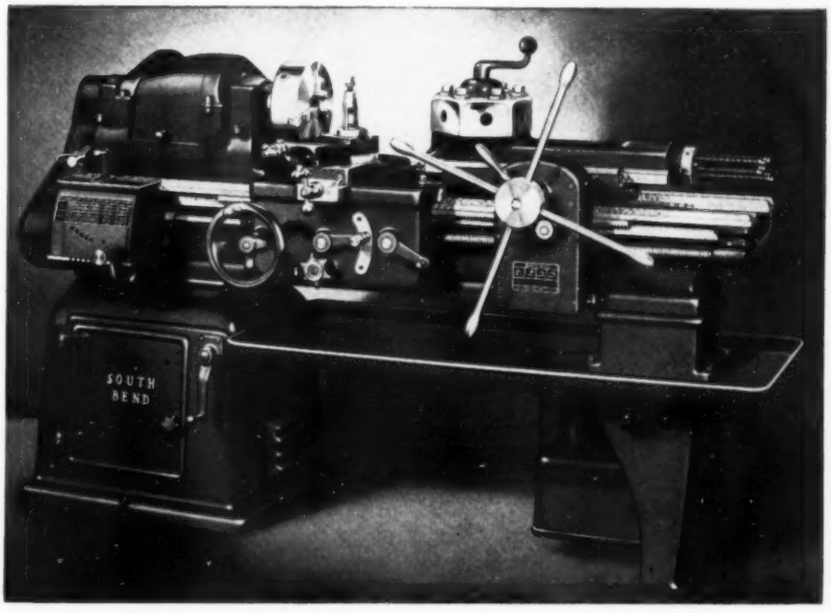
Cross Gear & Machine Co., 2350 Bellevue Ave., Detroit, Mich., has developed its No. 20 Universal milling machine with cutter spindle adjustable to any angle in any plane. This machine can be utilized for a wide variety of work: drilling, tapping, counterboring, spot facing, jig boring, slotting, grooving, keyway milling, face milling, end milling, contour milling, profile milling, die sinking, punch forming, spline milling and serrating among others.

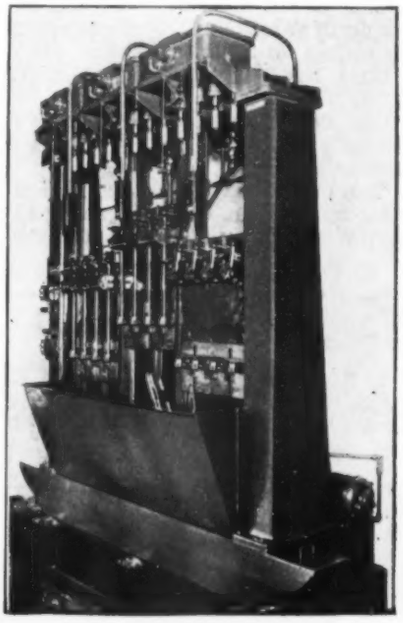
A direct reading spindle dial, reading in thousandths, aids in depth work. Overarm adjustment provides extra horizontal range for the cutter spindle. Angular settings are arranged quickly through graduated quadrants. Table working surface is 10½ x 36 in. Longitudinal travel is 20 in., cross travel, 9 in. Maximum distance between spindle nose and table top is 16½ in. Head can be extended 12 in. by the overarm. With the 1,200 r.p.m. motor, spindle speeds are available from 350 to 3880 r.p.m. With the 1800 r.p.m. motor they range from 520 to 5830 r.p.m.

South Bend's 16 In. Lathe Speeds Production, Cuts 48 Screw Threads

For rapid production on chucking operations and bar work, South Bend Lathe Works, 426 East Madison St., South Bend, Ind., have designed a 16 in. turret lathe. It has a 16¼ in. swing over the bed ways and saddle wings, 9⅝ in. swing over the tool post saddle cross slide, 1⅜-in. hole through the headstock spindle and 1-in. capacity through the collet. The ram type turret has both power and hand feed, with automatic indexing and individual stop for each of the six turret faces. A quick change gear box provides 48 different turret power feeds.

There are also 48 cross and longitudinal feeds for the tool post carriage. A series of 48 screw threads from 4 to 224 per in. can be made with this lathe. Direction and speed of turret with relation to the carriage speed can be changed at will. Twelve spindle speeds from 10 to 731 r.p.m. are available. For reaming and tapping operations, the two-speed motor permits quick high to low changes.





Long Hole Reamers Machine .30 or .50 Cal. Gun Barrels

Push and pull reaming of .30 or .50 cal. rifle barrels can be performed with the vertical, long hole, reaming machine made by W. M. Steele Co., 98-100 Beacon St., Worcester, Mass. The No. 1, .30 cal. machine, takes barrels from 22 to 28 in. long. The No. 2 reamer for .50 cal. handles 36 to 46 in. barrels. Spindles are grouped in units of four. Units are independent of each other in action and control. Thus, on the 12-spindle machine (illustrated) three sets of four barrels of different lengths can be reamed at different speeds. Reamers are attached to the spindles either by rigid connections or by quick-acting chuck. Coolant is pumped to the center of the hollow reamer shank to continually flush the reamer.

2 Spindle Hand Profiler Makes Gun Parts; Linear Milling Done Without Master Pattern

Intricate mechanical parts, such as those in the breech mechanism of small arms and machine guns, can be turned out by the red ring hand profiler made by National Broach & Machine Co., 11457 Shoemaker St., Detroit, Mich. The head carries two cutter spindles, 10 in. on centers, which can be used simultaneously. The head travel is 4 in. from center toward or away from operator. As the work table has a travel of 20 in. at right angles with the head movement, the total area which is covered by each cutter is 160 sq. in.

Normal operation is the duplicating in the work parts of the profile of a master pattern. But, by locking either head or table slide, linear milling may be done without using pattern. Horizontal movement of head and table is controlled by hand wheels. Each spindle has a micrometer adjustment for depth of cut and is counterbalanced by springs for instant retraction, when locking handle is released. Vertical cutter feed is actuated by cranks at either side of the head. Five spindle speeds are provided through stepped sheaves on spindle and shaft.

Tool drivers have a capacity for end mills up to ¾ in. diameter, and each carries a No. 9 taper. The follower pin, which in operation contacts the contour of the master pattern, is tapered on a 6 deg. angle to correspond with the angle on which the sides of the pattern are cut. These pins have a vertical adjustment of 1/16 in. to compensate for changes in cutter diameter, due to sharpening. Coolant is piped from a tank in base to a jet on each cutter.

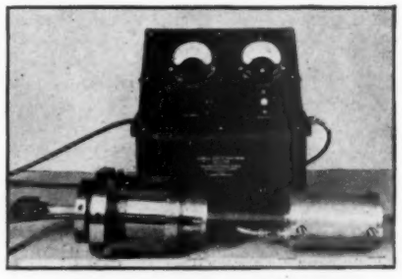
Press Fitted With Taper Unit Turns Out Conical Sections

Without special dies, conical sections can be made by a tapering mechanism now supplied on a line of bending presses made by the Steelweld Machinery Div., Cleveland Crane & Engineering Co., Wickliffe, Ohio. By simply operating a ram-tapering lever which disengages the ram clutch, the right hand screw raises or lowers the right end of the ram producing tapering. Either end can be tapered as much as one-quarter inch per foot of bed length.

The ram swivels on trunions in the slides, thus preventing cramping on guides or bearings. Model 14-10 (illustrated) will handle plate 10 ft. by 5/16 in. between housings and 12 ft. by ¼ in. over entire length of bed and ram.

Haskell Indicator Shortens Gun Barrel Straightening Time

For indicating eccentricity in tubes and gun barrels, the Haskell gun bore straightener indicator has been introduced by Baldwin-Southwark Division, the Baldwin Locomotive Works, Philadelphia, Pa. The instrument is offered in sizes from 37 mm. upward. With it, gun straightening operations which formerly required half a day can be completed in a fraction of the time. The device will detect an eccentricity of 0.005 in. or less, depending on the



concentricity of the roller tracks with the ends of the bore.

In operation, an induction head is moved in steps through the bore of the gun barrel which is rotated about the head at each step. An electrical circuit detects eccentricity by the variations of the magnetic gap between the

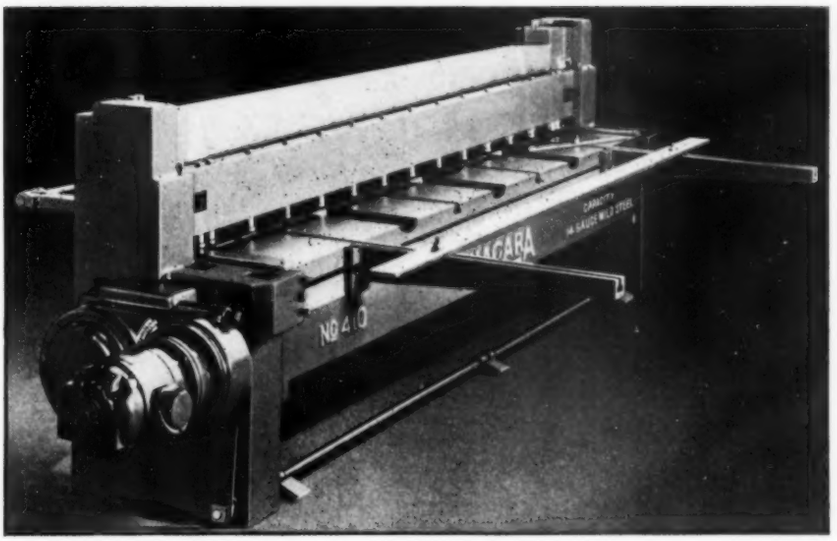
pole pieces of the induction head and the wall of the tube. Indicators are available for both cold and hot straightening operations. For the latter temperature must not exceed 800 deg. F. Requiring 110-volt, 60-cycle power supply, the equipment can be connected to any regular a.c. lighting circuit.

Foot Controlled Hydraulic Vise Develops Pressures to 5 Tons

Workmen can use both hands in setting up and removing work while operating the foot controlled hydraulic vise produced by the Studebaker Machine Co., Chicago, Ill. Capable of developing between jaw pressures up to five tons, the vise is designed to speed up small press and cutting operations

as well as ordinary vise work. Controls are arranged in a pedestal mounted on the floor. They are connected with the vise by a steel tube which carries the hydraulic fluid to a ram behind the back jaw. Front jaw is stationary.

One pedal moves the jaw to contact against the work. A second applies pressure up to 5 tons, while a third releases the jaw. The vise can be mounted vertically as well as horizontally. It will take special jaw faces. Two sizes are available: one with 5 in. width between jaws and the other with 7½ in. width.

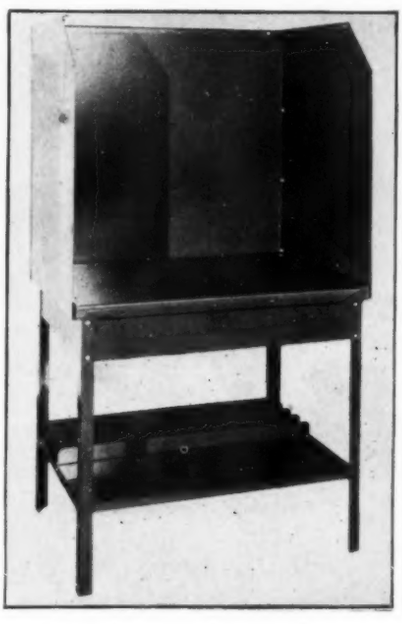


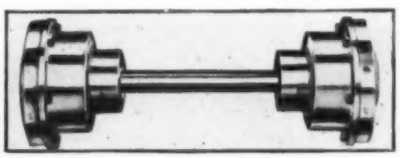
Shears Cut 75 Strips Per Minute From 12 to 16 Gage Metal Sheets

Power accuracy and production speed can be obtained with the series No. 4 power squaring shears recently announced by Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y. Metal sheets from 4 to 12 ft. in length and 12 to 16 gage, can be cut into strips whose edges are straight to within a few thousandths of an inch. Strips may be sheared at the rate of 75 per min. on 60 cycle current. This speed is made possible by the instant engagement of the sleeve clutch and the quick release of the holddown. Standard equipment includes a 3 phase, 60 cycle, 110 or 220-440 volt, a.c. motor, one pair of tool steel knives with four cutting edges, adjustable inlaid scale at each end of bed, front gage with two brackets, side and bevel gages and self-measuring back gage adjustable at 1/128 in. increments.

Gas, Arc Welding Benches Have High Shields, Storage Shelves

Welding benches, one for gas welding and another for arc welding, have been developed by Lyon Metal Products, Inc., 3011 Clark Street, Aurora, Ill. The arc welding bench has a 10 gage steel working top, 33 in. from the floor. A 35 in. shield extends on back and sides. Beneath the working top there is a storage shelf with four separators for welding rods. The frame of the gas welding bench is built to support a firebrick top 34 in. from the floor. It also has the storage shelf.





Outboard Bearings Eliminated On Falk's Type P Couplings

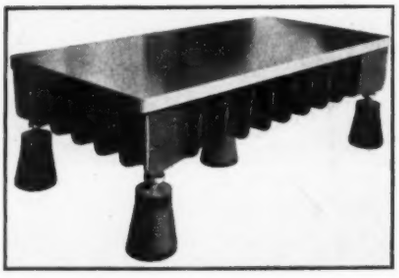
A piloted coupling for floating shaft requirements has been added to the line of Steelflex couplings manufactured by the Falk Corp., 3001 Canal St., Milwaukee, Wis. Known as Type P, these couplings have a low angle universal joint action which eliminates the necessity for an outboard bearing on extended shafts. It consists of two hubs, one of which has an integral flange to which the cover is secured. Cap screws secure the flange cover to the hub flange.

There are three Type P coupling applications: the single piloted, which will support long shaft extension; the double piloted horizontal, which is composed of two type P couplings with

connecting shafts; and the double piloted vertical composed of two type P couplings and the connecting shaft for assembly and vertical drive where distance between drive and equipment shaft is considerable.

Surface Plate by South Bend Finished Plane Within .005 In.

Finished plane within 0.005 in., a 48x96 in. surface plate is being cast by South Bend Tool & Die Co., 2100 S. Main St., South Bend, Ind. Ten or 12 in. adjustable block legs provide working-



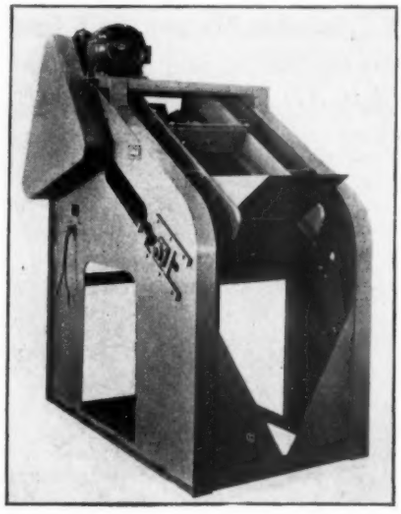
surface heights between 29 and 33 in. Twelve-pitch thread on the 1½ in. screws, supported by the 5 leg blocks, provide fine adjustment to compensate for floor irregularities. Under side of the plate is ribbed to provide maximum strength without excessive weight. The weight is 3 tons.

Instant Reversing Motor Made For Lathes, Cranes and Hoists

For use on lathes, cranes, hoists, and other industrial applications where instant reversing is necessary, a capacitor-start reversing motor has been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Available in ratings of from 1/6 to ¾ hp., single-phase 60 cycle, the motor operates at 1,725 r.p.m. To reduce maintenance, no brushes or commutators are used. Motor is reversed by simply throwing a drum switch.

Reclamation of Mixed Materials Aided by Magnetic Separator

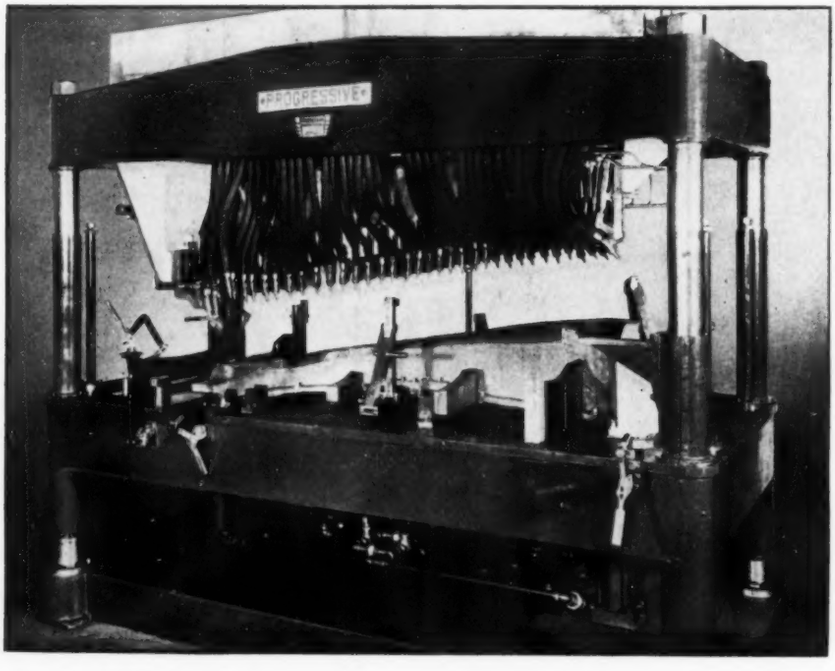
For use where reclamation of mixed materials can be effected by magnetic separation methods, Stearns Magnetic Mfg. Co., Milwaukee, Wis., has introduced Type LD magnetic separator. Material is fed through a spout onto a fast moving belt conveyor set at an angle of 30 deg. and equipped with skirt boards to prevent spillage. Ma-

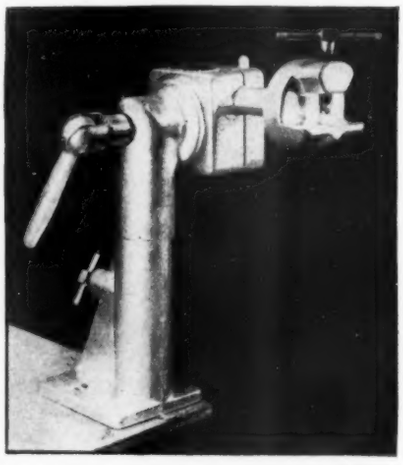


terial leaves the belt at high velocity to meet the face of a heavy, nonmagnetic screen which separates the fines from the coarse before material reaches the magnetic drum. Metallic particles are attached to the drum.

Assembly Unit Makes 3,600 Welds Per Hour; Cycle Takes 40 Sec.

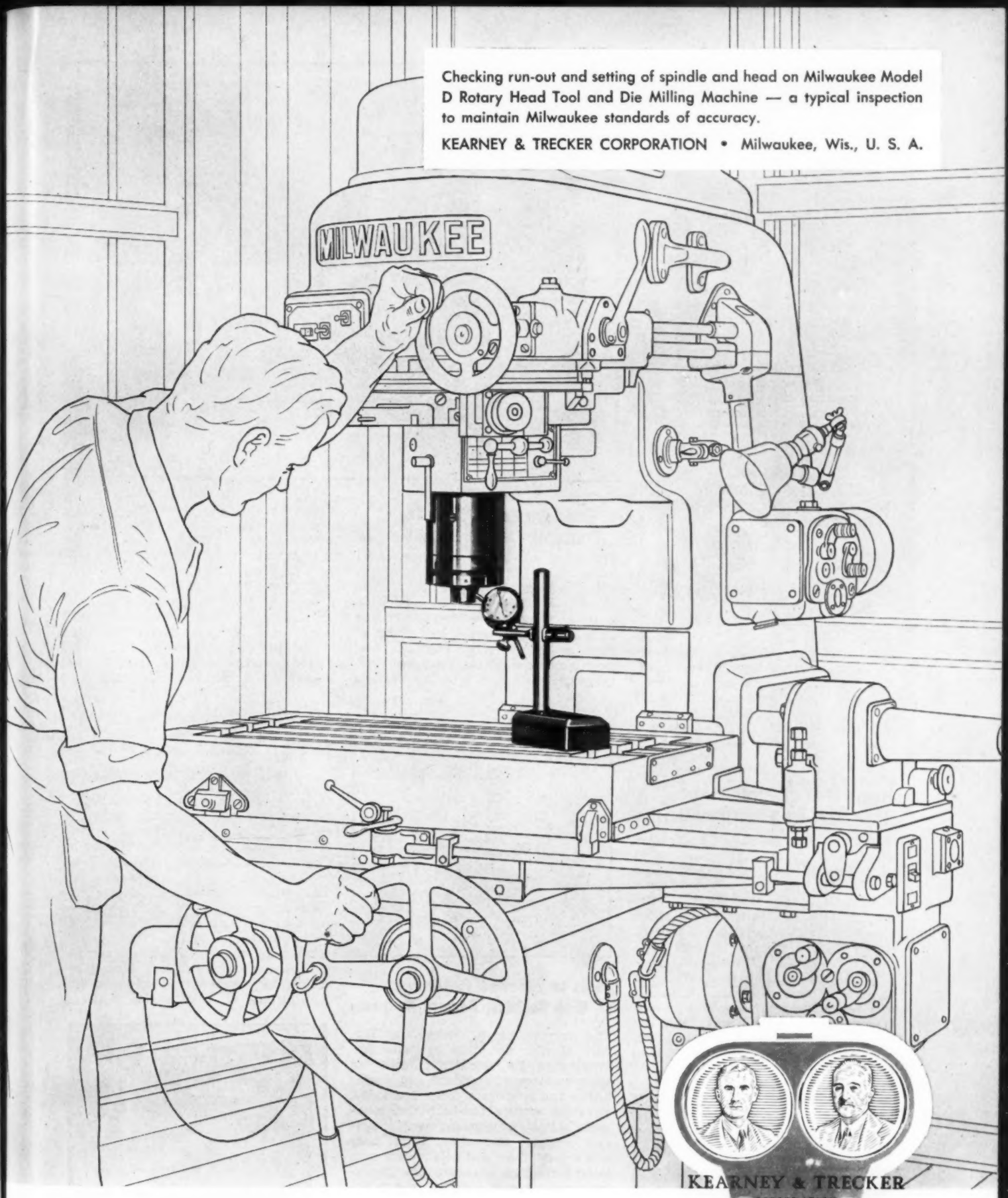
With the ultra-speed unit built by Progressive Welder Co., 3100 E. Outer Dr., Detroit, Mich., 3,600 assembly spot welds can be made in an hour. Complete cycle of the unit requires only 40 sec. This includes time for loading and unloading the fixture, bringing the 40 points against the work, and going through the welding cycle, two welds at a time.





Jig Holds Parts in Any Position; Cast Iron Prevents Freezing

Easily adjusted to any position, the welding jig recently introduced by Stoody Co., Whittier, Calif., was designed for use in the hard-facing of small equipment. All parts are made of cast iron, eliminating any danger of the working parts freezing at high temperatures. One joint permits vertical rotation of the neck, head and work clamp as a unit. Two others permit



Checking run-out and setting of spindle and head on Milwaukee Model D Rotary Head Tool and Die Milling Machine — a typical inspection to maintain Milwaukee standards of accuracy.

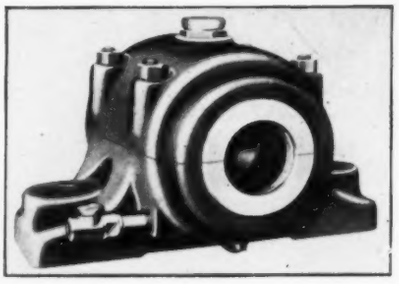
KEARNEY & TRECKER CORPORATION • Milwaukee, Wis., U. S. A.

Milwaukee MILLING MACHINES

combined vertical and horizontal rotation of the work clamp. A tension nut either securely locks head and work clamp or merely holds them under tension so that parts can be turned easily with rod or torch.

Water Cooled Pillow Blocks Work Under Heavy Loads, Rubbing Speeds

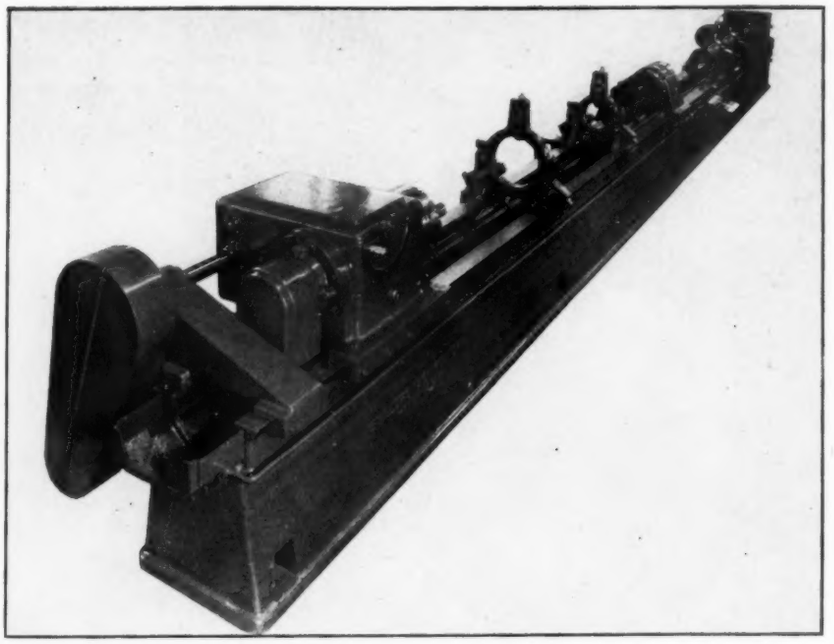
Water cooled and plain pillow blocks in shaft sizes from 1 7/16 in. to 8 in. have been designed by Dodge Mfg. Corp., Mishawaka, Ind., for use where high grade babbitted bearing is required. Bearings are self-aligning. For elevated temperatures, heavy loads or rubbing speeds, the water cooled blocks are particularly adaptable. Sizes up to 3 15/16 in. are water cooled in the lower liner with one inlet and outlet connection. Sizes above this are cooled in



both upper and lower liners and have double connections. Special seals held onto the shaft by garter springs prevent dirt from getting into the mechanism and escape of lubricants. Bases, ends and spherical seats are finished, and dowel pin holes are provided.

Stamps With Different Borders Aid Inspector Identification

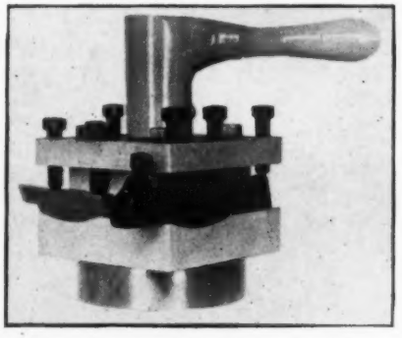
To simplify inspector identification arising from triple shift operations in defense industries, a set of stamps have been brought out by the New Method Steel Stamps, Inc., Detroit, Mich. The stamps are numbered from 1 to 99, but the numbers in each group are inclosed in identifying shaped borders. One group is inclosed in squares, another in triangles, another in circles, and another in ovals. Identical numbers can be assigned to inspectors or operators doing identical work. Men are identified by the borders. These stamps are available in sizes from 5/32 to 5/16 in.



105mm. Gun Boring Unit, Tools Protected From Overload Damage

The No. 3 gun barrel boring machine introduced by Builders Iron Foundry, 9 Codding St., Providence, R. I., will handle barrels up to 105 mm. bore. Barrels, mounted in headstock, are driven by a four speed a.c. motor at from 20 to 375 r.p.m. Fourteen feed rates are provided for the boring bar, ranging from 0.2 to 3 in. per minute. Carriage can be moved in either direction at a rapid rate—60 in. per minute.

Machine and tools are protected against overload damage by an adjustable holding device for the boring bar. If the torque on the bar exceeds a set limit, the tool is released in the carriage and the spindle and feed motors stop. Standard boring length is 156 in., but machines can be furnished to accommodate longer barrels. Diameter of the spindle hole is 4½ in.



Tools on Hercules Turret Fitted With Rockers, Require No Shims

The Hercules turret, designed by William M. Orr Co., 1228 Brighton Rd., Pittsburgh, Pa., mounts directly on cross carriage of standard and engine lathes and holds four tools. Individual elevating rockers for each tool eliminate shims and obviates need of special grinding. Size of the turret body is 4 x 4 in. Base and height vary with lathe for which intended. The indexing mechanism is provided to lock accurately in four positions. One tool, however, may be used in several positions as turrets can be locked at any point between regular indexing positions.

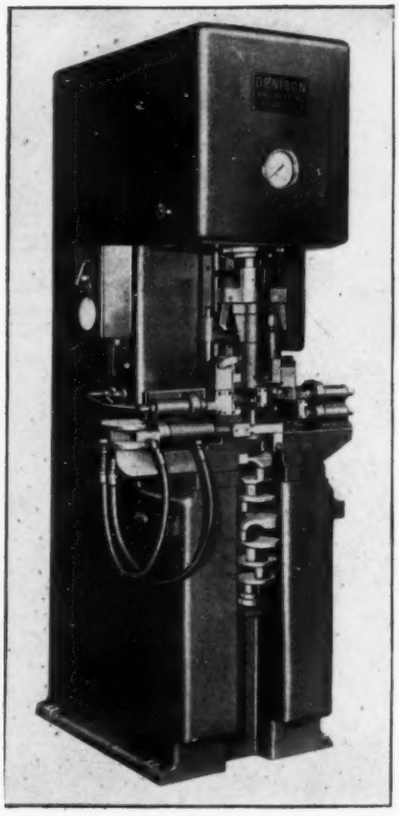
Test Thermocouple Temperatures Direct With Micromax Indicator

Direct measurements of thermocouple temperatures can be taken with an automatic indicator, Micromax Model S, introduced by Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. As many as 50 couples can be used with one instrument. All are individually connected to toggle switches on the indicator front. To read a thermocouple temperature, the operator simply throws its switch and a pointer moves automatically to the correct scale position. The case is 20 in. high by 18¼ in. wide by 12⅝ in. deep.

PUTTING MORE BRAINS IN BRASS. Men make brass. Previously, we have shown you some of the men who put the human touch into copper and copper-base alloys for Revere Copper and Brass Incorporated. Here is an example of the equipment that helps them do it—by freeing their energy for things that call for headwork. This "roller coaster" handles materials with the efficiency of a well-run railroad. Because it lets skilled men use brains instead of brawn, it helps to put more brains behind the metals you get from Revere. This machinery, built in 1938, is indicative of the foresight which enables Revere today to meet the ever-growing needs of the national emergency—and which will enable Revere tomorrow to supply more and better materials for the re-birth of American industry. Revere Copper and Brass Incorporated, 230 Park Avenue, New York.

Adapt Press for Timing Gear, Key Assembly on Crankshafts

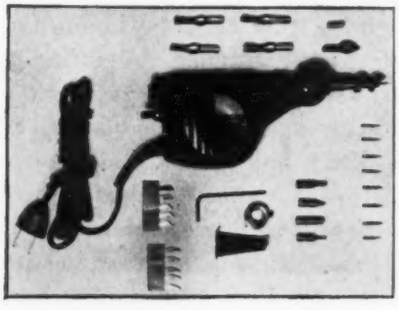
A 5 ton hydraulic press has been adapted by the Denison Engineering Co., West Chestnut St., Columbus, Ohio, for assembling keys and timing gears on automobile crankshafts. After the crankshaft has been locked in place, the keys are fed into the press

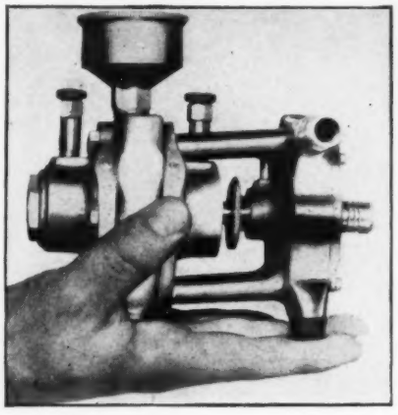


through magazines. Four cylinders assemble the two keys and the timing gear is pressed into place by the ram. If the keys are not pressed into place, the operation of the ram is stopped. Another safety feature is the rejection of pieces when the timing gear does not fit.

Vibro-Tool Engraves, Hammers, Carves Metals; Used on Templets

Operating on a vibrating principle at the rate of 7,200 strokes per minute, the Vibro-Tool, recently announced by Burgess Battery Co., 180 N. Wabash Ave., Chicago, Ill., can be used for engraving, cutting, hammering and carving on metals and other materials. Besides being used for marking tools, machines, parts and fixtures, the Vibro-Tool can be used to cut or engrave to a templet, to engrave instrument panels and dials.





Small, Air Powered Pump Has 15 Gallon Per Minute Capacity

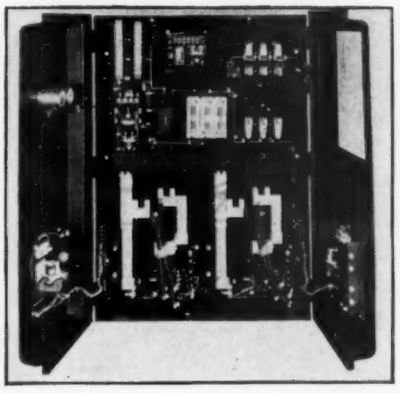
A midget size, air powered pump, weighing but 10 lb., has been developed by Eastern Engineering Co., 45 Fox St., New Haven, Conn. For use in industrial, pilot, laboratory and experimental applications, the pump is threaded for ¼ in. pipe fittings. Operating on an air pressure of 100 lb. its capacity is 15 g.p.m., with a maximum pressure of 34 lb. per sq. in.; on 50 lb. its capacity is 12 gal. and pressure 24 lb.; on 20 lb. its capacity is 7½ gal. and pressure 13 lb. Pumps are available in stainless steel, monel, chromium plated bronze, brass, cast iron and other alloys. Air consumption at maximum speed is 5 cu. ft. per min. Size is 5½ x 6 x 7 in.

Fluorescent Lighting Unit Starts Instantly; 2 Surfaces Offered

The Fostoria Pressed Steel Corp., Fostoria, Ohio, has equipped the Model MF-240-N fluorescent lighting unit with instantaneous starting. No starting switches are required, as lamps go on and off in the same manner as conventional incandescent units. Reflecting surfaces offered are Matte-white enamel and gloss white enamel. Many exterior finishes are offered.

All Power, Control Elements Included in Weltronic Cabinet

Complete power and control units for resistance welding, including in one compact cabinet contactors, firing relays, sequence timer, protecting fuses, limit switches, motor starter, low voltage transformer and relay, are being produced by Weltronic Corp., 3051 E. Outer Drive, Detroit, Mich. These units



are assembled in steel panel cabinets to meet individual users requirements and are available for any type of welding equipment.

Composite Cutter Blanks Save High Speed Steel, Wear Better

At least ½ the quantity of high speed steel previously required in making dovetail forming cutters can be saved by using composite steel blanks made by The Forging and Casting Corp., Ferndale, Mich. The blanks are made by electrically welding a cutting face of high speed steel to a non-hardenable base of mild steel. Besides the saving of strategic metal, tools made from these steel blanks have this advantage over the usual solid high speed steel construction; the non-hardenable test base minimizes the tendency of the sharp dovetail corners and screw holes to break out during heat treating or under working strain.

B & S Adds Large Magnetic Chuck, Another With Hardened Top Plate

A large size rectangular magnetic chuck, Type No. 1236, has been added to the line manufactured by Brown & Sharpe Mfg. Co., Providence, R. I. It has a working surface of 12⅛ x 36 in.,

and a magnetic surface approximately 9½ x 29 5/16 in. Height is 4⅞ in. A rectangular permanent magnet chuck with hardened top plate has also been announced. It is useful for work which might scar or mar the surface of a regular chuck.

Workers Tools, Personal Effects, Records Stored in Drawer Units

Two and three drawer units for individual storage of workers' tools, records or personal effects are being put

DIE LIFE DOUBLED *with* SUNICUT

P-Q* SET AT A NEW HIGH!

The tougher the test . . . the more decisive the proof of SUNICUT's outstanding quality as a cutting oil . . . and proof that it allows a higher P-Q* to be set.

This was again proved by engineers of one of the largest manufacturers of steel pipe. Their defense and supply requirements demanded longer die life on pipe threading operations. Actual tests run on thousands of feet of pipe proved SUNICUT doubled the die life as compared to tests made with the best competitive cutting oils.

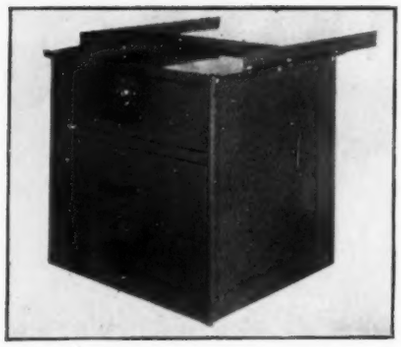
Now their 16 machines are operating at a rate of 39' per minute . . . and they've set a new high in P-Q* of 1,440,000 feet of pipe for every twenty-four hours of operation.

Amazing? Yes, but typical of the records set by this modern, production-proved, sulphurized cutting oil. If you're interested in keeping your machine-tools running at rated capacity-plus and establishing a higher Production Quota* . . . call in a Sun Oil Engineer and get the facts on SUNICUT.

SUN OIL COMPANY, Philadelphia, Pa.

SUN OILS

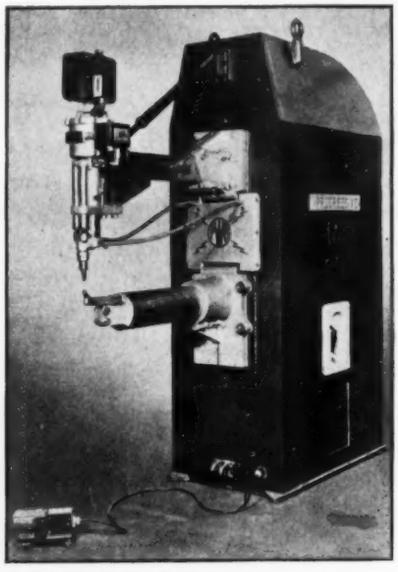
PETROLEUM PRODUCTS FOR ALL INDUSTRIES

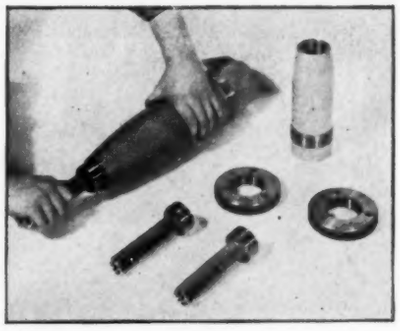


out by the Lyon Metal Products, Inc., 3011 Clark St., Aurora, Ill. The units, equipped with flat key locks, can be attached to work benches, tool stands, shop desks and under counters.

Tube Construction Eliminates Lower Arm Braces on Welder

For resistance spot welding inside deep assemblies such as tanks and barrels, Progressive Welder Co., 3100 E. Outer Drive, Detroit, Mich., has introduced a deep throat welder. Heavy tube construction of the lower arm eliminates the usual braces and makes possible the sliding of deep assemblies over the arm to full throat depth. The conventionally braced upper arm carries upper electrode and gun assemblies. When the unit to be welded has been properly located on the lower arm, the upper electrode is hydraulically lowered into the welding position and the weld cycle is initiated. When completed, electrode is withdrawn.



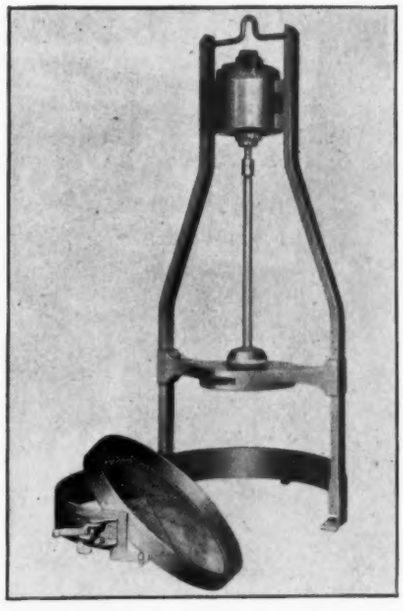


Inner, Outer Shell Threads Checked by Precision Gages

Internal and external threads on shell can be checked by means of precision thread gages brought out by the Detroit Tap & Tool Co., 8432 Butler Ave., Detroit, Mich. Plug gages for internal threads are reversible, virtually doubling useful life. Adjustable ring gages may be reconditioned and reset when worn.

Riddle Mixes, As It Sifts Sands Faster Than Man Shovels

Molding and core sands are sifted and mixed in one operation by the gyratory foundry riddle put out by the Jefferson



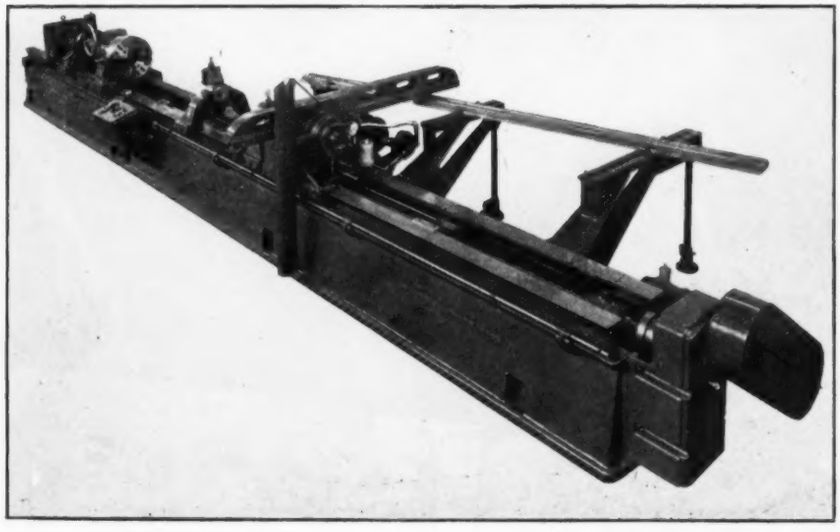
Machine Tool Co., 4th, Cutter & Sweeney Sts., Cincinnati, Ohio. The 20 in. diameter sieve will handle sand faster than one man can shovel it. Drive is direct from a 1/6 hp. motor at 900 r.p.m. Length is 4 ft. 8 in.

Builders No. 3 Machine Rifles 105 mm. Gun Barrels 156 In. Long; Has Adjustable Sine Bar

Builders Iron Foundry, 9 Codding St., Providence, R. I., have introduced a rifling machine for 105 mm. gun barrels. Designed for barrels 156 in. long, it can be specially equipped for longer or shorter barrels. Using a push type broach, it has cutting speeds of 10, 15 or 20 ft. per minute. Return speed is 30 ft. per minute.

Swing over bed is 20 in. An adjustable sine bar is furnished for cutting a spline of any desired pitch. This can be removed after splining the rifling bars. The tubular type cutting bar, secured in the headstock, is supported by a fixed guide and two movable guides. Indexing of barrel is done manually with a handwheel driving through a worm and worm wheel. It causes the revolving of a dividing head which indicates position of the grooves to be rifled.

The machine is driven by a four speed motor through a vee belt at 600, 900, 1200 and 1800 r.p.m. Guards cover all moving parts.



Light Weight Dies From Masonite Have Long Life, Reduces Costs

Because of low initial cost and speed of processing, light weight dies made from Masonite stock, produced by the

PRECISION PRODUCTION
. . . — *vital to* VICTORY

The swift and gigantic steps that American industry is taking in the program for national security are largely due to the *precision production* of metal parts. When the present emergency is ended, the record will show that one of the outstanding accomplishments was the production of defense material, not only in stupendous quantities but with each vital metal part repeatedly held to an extremely high standard of accuracy in size and finish. Today, in the midst of this emergency, Ex-Cell-O standard machine tools are performing numerous precision jobs in practically every industry engaged in defense work. They are taking an important part in making possible the speed and accuracy upon which success depends.

Illustrated here is an aircraft part being bored on Ex-Cell-O Precision Boring Machine (Style 112-C) with Ex-Cell-O Universal Fixture. Standard Ex-Cell-O Boring Machines are used extensively in production because of their ability to hold extreme accuracy in size and finish.

Picture below shows one of many precision parts being produced for airplanes on Ex-Cell-O Standard Thread Grinding Machines (Style 31 is shown here). Precision thread grinding is now universally employed in the production of all vital threaded parts used in aircraft.

EX-CELL-O
CORPORATION
DETROIT
MICH.

The plane illustrated to the left is the Curtiss P-40, a single seat low wing pursuit plane, many of which are being produced daily by the Curtiss-Wright Corporation. Ex-Cell-O precision machines, producing close-limit aircraft parts for this plane, are shown above.

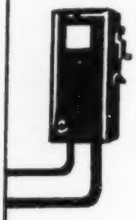
XLO

Precision THREAD GRINDING, BORING AND LAPPING MACHINES, TOOL GRINDERS, HYDRAULIC POWER UNITS, GRINDING SPINDLES, BROACHES, CUTTING TOOLS, DRILL JIG BUSHINGS, PARTS

Bill-- Here's a tip to help you get that new plant operating sooner

"We've found that we can save as much as 50% of the time required for installing control by using G-E combination starters for the motors in our plant." ★

HERE'S WHY G-E COMBINATION STARTERS CAN BE INSTALLED MORE QUICKLY



THIS	Instead of	THIS
1	Devices to mount	2
2	Lengths conduit to cut	3
2	Conduit ends to thread	4
6	Wires to pull	9
6	Power connections to make	12

★ *Statement by R. L. Mitchell, master mechanic, Fernstrom Paper Mills, Inc., Pomona, Cal.*

GENERAL ELECTRIC

Masonite Corporation, 111 West Washington St., Chicago, Ill., are less expensive than those made from steel or other metals. Masonite can be processed on all types of wood working equipment to form long wearing dies for shearing, forming and spinning sheet metal, especially aluminum alloys. Stock comes in sheets 48x72 or 144 in. and in nine thicknesses from ¼ to 2 in. It will withstand a compression of 26,000 lb. per sq. in.

TRADE PUBLICATIONS

CENTRIFUGAL PUMPS Allis-Chalmers Mfg. Co., Milwaukee, Wis., has issued an 8 page booklet (B-6059) which describes and illustrates centrifugal pumps for handling from 10 to 200,000 gal. per minute.

COMPRESSORS Pennsylvania Pump & Compresser Co., Easton, Pa., has recently issued Bulletin 194, describing its heavy duty, horizontal, single-stage air and gas compressors.

DUST COLLECTION Unit type collectors for attachment to grinders, planers, blast cleaning units, tumbling mills and other equipment creating dust are described in Bulletin 907 put out by Pangborn Corp., Hagerstown, Md.

FLEXIBLE BEARINGS Engineering data including operating characteristics for Torflex flexible bearings are given in an 8-page folder issued by Harris Products Co., 5416 Commonwealth Ave., Detroit, Mich.

FLEXIBLE SHAFT MACHINES Flexible shaft equipment for grinding, polishing, boring and other operations in manufacture of airplanes, engines, parts, marine accessories, automobiles and dies are described in Bulletin FS-41 published by Walker-Turner Co., Inc., 604 Berckman St., Plainfield, N. J.

FURNACE CONTROLS Why, how, when, and where furnace pressure controllers can be used to maintain constant furnace pressure are discussed in an eight-page Bulletin No. 74-2, published by the Brown Instrument Co., Wayne and Robert Aves., Philadelphia, Pa.

ISOLATING VIBRATION A 12 page catalog published by the B. F. Goodrich Co., Akron, Ohio, discusses vibration insulation problems. Applications of mountings on various types of equipment are listed, together with characteristics.

LATHES Specifications and capacities of South Bend lathes are described in catalog No. 52 recently published by South Bend Lathe Works, 425 E. Madison St., South Bend, Ind.

OIL COOLERS Complete engineering service for oil quenching installations is offered by the Bell & Gossett Co., 3000 Wallace St., Chicago, Ill., in its recent bulletin describing B & G rapid oil coolers.

POWDER METALLURGY Production of bearings, gears, cams and miscellaneous parts from powdered metals is discussed in a bulletin just issued by Moraine Products Division, General Motors Corp., Dayton, Ohio.

SHIPBUILDING In the July 1 issue of *The Booklist*, part 2, published by the American Library Association, Chicago, Ill., W. P. Leidy has listed 149 books on shipbuilding and marine engines.

STEAM CLEANING Homestead Valve Mfg. Co., Inc., Coraopolis, Penna., has published an 8 page catalog listing specifications and uses of Hypressure Jenny steam cleaners.

THERMOCOUPLE DATA Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill., has published Bulletin No. S2-3 on thermocouples. Data in its 32 pages includes temperature conversion tables, millivolt tables, pipe and wire sizes, decimal equivalents, wire resistances and checking and repair of pyrometers and thermocouples.

NEW BOOKS

THE STARRETT BOOK FOR STUDENT MACHINISTS—*184 pages. Published by the L. S. Starrett Company, Athol, Mass. 75 cents.*

Combined in this volume is the material formerly published in two separate books by the L. S. Starrett Company. It has been revised and brought up-to-date in cooperation with vocational school and industrial training instructors.

The present volume includes a range of subjects with which the student and young machinist should be familiar: how to read working drawings, how to use precision tools and measuring instruments, how to read a micrometer and a vernier, how to work to standard fits and tolerances, and in addition practical instructions on bench work, lathe work, drilling, metal sawing, screw threads and tapers, jigs and fixtures, and toolmaking. The book contains over 200 illustrations and 30 reference tables.

•

BLUE PRINT READING AND SKETCHING—*By H. R. Thayer, assistant professor of engineering drawing, The Pennsylvania State College. 140 pages. Published by McGraw-Hill Book Company. $2.*

This book is designed especially for teaching adult classes. While it may be found useful in colleges and in

Thanks Joe . . . we're already using combination starters . . . they're safer

"We have found that our men can maintain G-E combination starters without danger, thanks to the safety-interlocked enclosure which separate units do not have."★

1 **SAFER** because the circuit switch has ample capacity to interrupt stalled-rotor current of the controlled motor.

2 **SAFER** because the cover can't be opened as long as the switch handle is in the ON position and power is applied to exposed parts.

3 **SAFER** because, whenever the cover is open, power can't be applied to the starter by accidental closing of the switch handle.

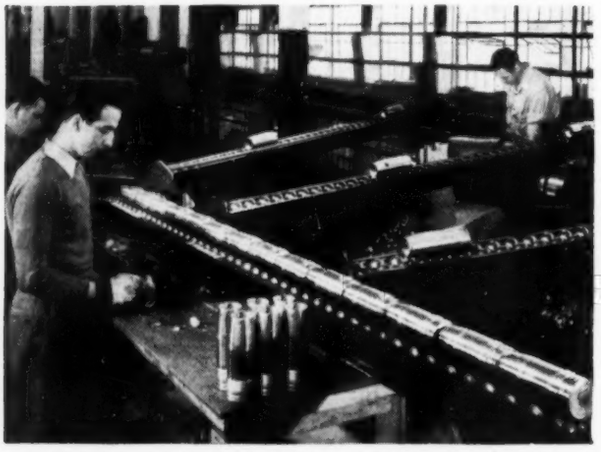
★ *Statement by Raymond Dingler, chief electrician of a large western cement plant*

Send for "How to Get More for Your Control Dollar" (GES-2456) General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

STANDARD CONVEYORS

"First Line" Equipment in Armament Production!



Standard Conveyors of a Special Spool Type are used in large plant for line production of 3 inch A. A. Shell. View shows a portion of the extensive Standard Conveyor system used to carry shell, safe and fast, through various stages of production.

Conveyors—planned and installed by Standard—are a basic part of the high-speed, mass-production equipment increasingly being called into use to step up defense production. They are of vital importance in cutting short handling time, eliminating repeated handling, avoiding wasteful waiting for materials—they help speed production all along the line.

TO SPEED PRODUCTION . . . CONVEYORIZE

In every plant there are production operations which can be "conveyorized" with substantial savings of space, time and costs. Handling incoming material—work in process—moving finished products to shipping or storage—at any one or all of these points Standard Conveyors can substantially step up production.

Send for Bulletin AM-10 "Conveyors by Standard," showing what Standard has done for many manufacturers.

STANDARD CONVEYOR COMPANY

General Offices: North St. Paul, Minnesota

Sales and Engineering Offices in Principal Cities

FIRST FOR FASTER PRODUCTION

"THE STANDARD OF VALUE"

Standard CONVEYORS

industrial courses for younger students, it is designed to remedy the lack of material available for older men particularly those already engaged in industry. The volume is part of a series prepared by the staff of the School of Engineering, of the Pennsylvania State College.

The book does not confine itself to shop work, but embraces the subject of blue print reading and sketching in a broad way. For instance, it includes such subjects as plans and maps, building details, reinforced concrete, power transmission diagrams and pipes and their fittings.

The book is attractively prepared in a wire binding; by the use of blue ink it gives a realistic appearance to the illustrations. Folded in a pocket in the cover are a number of blue print type sketches whose size does not permit binding in the book.

•

MACHINE SHOP TRAINING COURSE: SECOND EDITION—*By Franklin D. Jones. Vol. 1, 538 pages; Vol. 2, 552 pages. Published by the Industrial Press, 148 Lafayette St., New York, N. Y. Price, two volumes, $6; either volume separately, $4.*

Because of the timely need for industrial education, the second edition of this work has been published with the inclusion of some new material. One of the new features is a series of blueprint reading charts. These cover 29 pages, all in color, and show by a simple progressive method how to understand technical drawings. The charts are especially designed to illustrate the fundamental principles of blueprint reading. They are supplemented by an explanation of the meanings of various standard abbreviations and symbols.

The second edition also contains another new feature: a chapter on "Engineering Standards Applied in Machine Building." This chapter covers standards of especial importance to the machine shop.

Together with the original contents of these volumes, the work comprises a comprehensive course in machine shop training. The presentation throughout is highly practical and is illustrated with machine set-ups.

•

METAL PROCESSING—*By Orlan Wm. Boston, professor of metal processing, University of Michigan. 630 pages. Published by John Wiley & Sons, 440 Fourth Ave., New York, N. Y. $5.*

Professor Boston, in one volume, offers a revision of two volumes on engineering shop practice combined with more recent data. The result is essentially a textbook, but one which will serve for industrial as well as for college courses.

The author starts appropriately enough with the steps in planning the product for manufacture, which in-

clude such considerations as engineering materials, how they may be obtained, bills of material, time studies, and route sheets. He proceeds then to cutting tools, to machine tools of all the various classifications and the questions that arise in their practical use. He treats also of press work, diecasting and molding, and measuring and gaging.

Professor Boston's work is illustrated with views of machine set-ups and sketches of small tools, including their correct cutting angles. He strives at all times to give the student a practical rather than a theoretical insight into shop procedure.

•

BLUEPRINT READING FOR THE MACHINE TRADE—*By John J. Weir, instructor in mechanical drawing, William L. Dickinson High School, Jersey City, N. J. 82 pages. Ring binding. Published by the McGraw-Hill Book Company, 330 West 42nd St., New York, N. Y. $1.25.*

This book is designed to provide an inexpensive volume which will quickly enable the young man new to industry to obtain a practical working knowledge of blueprint reading. As such, it is suitable for trade schools and a wide variety of other industrial courses.

The book is arranged to build up from simple beginnings a familiarity and a feeling for the graphic language of the engineer. The author also starts with a brief explanation of what a blueprint is and what it does. He describes the rules of projection and shows how perspective views can be translated to projected views. He tells something of measurement, particularly as applied to the dimensions used in mechanical drawing.

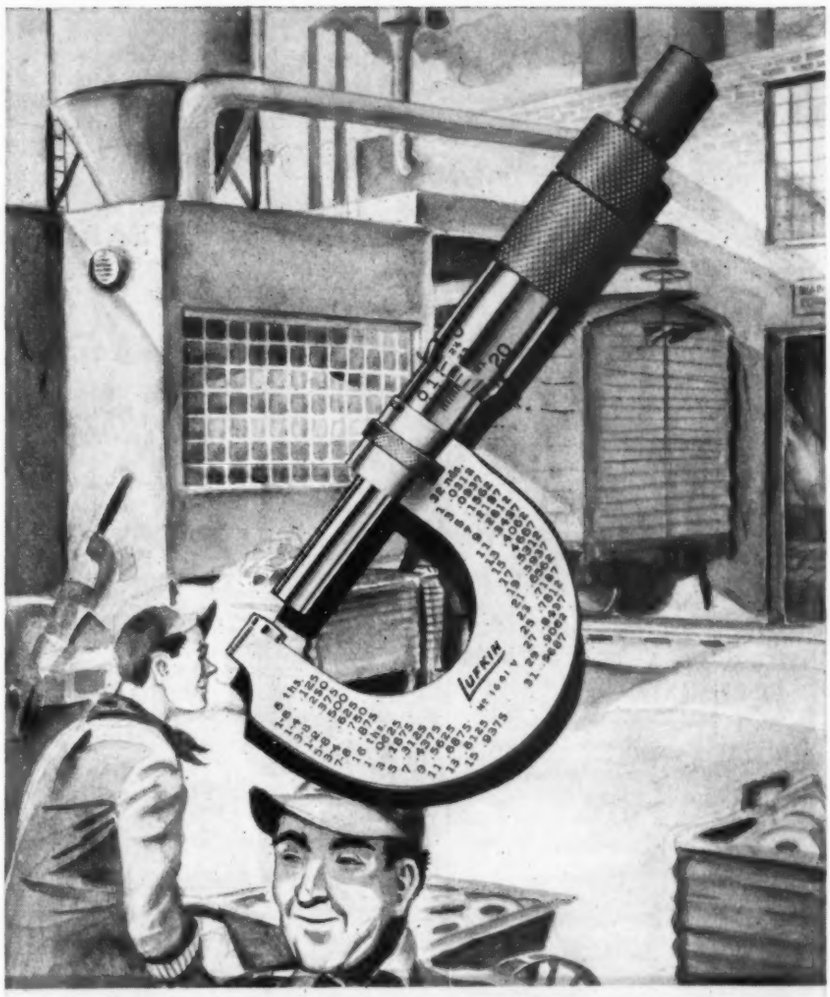
And so on through the various conventions and standards so familiar to the experienced shop man, but often terribly confusing to the youngster who has a feeling for machine work, but only a hazy idea of how white lines on blue paper can be transformed into metal.

•

MACHINE TOOL OPERATION: PART I, 3RD EDITION—*By Henry G. Burghardt, formerly head of machine shop, William L. Dickinson High School, Jersey City, N. J. 420 pages. Published by McGraw-Hill Book Company, 330 W. 42nd St., New York, N. Y. $2.25.*

Those who are familiar with Mr. Burghardt's previous editions know that this work is directed to the young man who wishes to become a machinist or better still who aspires to a supervisor's position in the machine shop. From his teaching experience, Mr. Burghardt knows that lectures and shop work while essential to any well organized industrial course should be supplemented by a permanent reference to which the student can turn to refresh his mind after many details of previous work have been forgotten.

As in the past Mr. Burghardt has



Where there's *Production* there's *Precision!*

America is busy. You can hear the roar of machinery inside factory walls from Maine to California. There's a fever pitch of activity, behind which Precision plays a more dominant role than ever before. Closer tolerances must be maintained—and they must be arrived at quickly. Costly errors are out! That's why Lufkin Precision Tools are today being specified by experienced manufacturers, machinists, and production men everywhere. They're designed to give the greatest degree of accuracy with the least amount of effort and at the smallest risk of human error. An examination of any of our many Precision Tools will convince you. Simply ask for our free catalog or see your dealer.

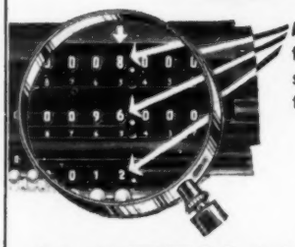
BUY THROUGH YOUR DISTRIBUTOR

LUFKIN

SAGINAW, MICHIGAN • New York City

TAPES RULES PRECISION TOOLS

for calculating
Jig Boring Centers
and other uses!



All 3 factors stand in full review

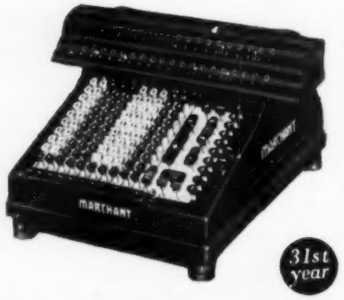
MARCHANT

the electric calculator with straight-line true-figure dials for ALL 3 FACTORS!

It's not economical for high-wage employees to figure with pencil and paper, because MARCHANT will give "the answer" in a jiffy... correctly pointed off... with all three factors in plain sight for checking.

This is why MARCHANT is so popular in shop and drafting room... for all work where slide-rule accuracy does not suffice.

Try an Automatic Electric MARCHANT at our expense. They're priced to fit your job... budget terms if desired.



31st year

TEAR OFF COUPON AND MAIL TODAY!

MARCHANT CALCULATING MACHINE COMPANY
HOME OFFICE: OAKLAND, CALIFORNIA, U. S. A.
Sales Agencies and Manufacturer's Service Stations Give Service Everywhere!

Gentlemen:
- ☐ We wish to try a Marchant at no obligation to us.
- ☐ Send "7 place Natural Trig. Functions with Increments to Seconds" (25 cents in stamps enclosed).
- ☐ Send "Simplified Sq. Root Method" (no charge).
- ☐ Send pamphlet "Conversion of Decimal Ratio to Common Fraction for Gear Design" (no charge).

Firm _____

Individual _____

Address _____

A.M. 10-1-41

divided the book into two volumes. Part 1, on the lathe, bench work and work at the forge, is now available in the third edition. The chief change in the current edition has been to add a chapter on hand forging in the machine shop.

SEEN and HEARD

By JOHN GODFREY

Where Temperature Counts

Temperature is becoming more of a factor in shop operations, not only in heat-treating but in the machining of parts where thousandths of an inch count. Teeth of large gears are now being cut in constant temperature rooms. The Essington plant of the Westinghouse company now has each of its large gear hobbers in a separate room in which the desired temperature is maintained night and day. The roof of each room slides back to let the crane handle work in and out of the machine, after which it is closed and temperature maintained until the job is done. Where gearing must transmit large power at high speeds, even slight variations caused by temperature changes must be avoided.

Forgings Pay

The forging of aluminum and similar alloys is growing in favor. Aviation engine builders are using them on parts that were formerly made as castings. Reduction in rejects caused defects in castings is said to offset the difference in cost. This increased dependability affects not only losses caused by labor on defective castings but also in the cost of inspection.

Want Less Tolerance

Standardization committees are frequently criticized for setting tolerances that are unnecessarily close. So-called practical men are likely to feel that the tolerances are unworkable in practice and accuse the committee of being too theoretical. So it is interesting to note a case in reverse NEMA has asked for closer tolerances in the fit between the two halves of flanged couplings. They say the present standards (B49-1932) give more tolerance than is satisfactory for this work. It is part of the progress from the time when a "scant 64th" was considered accurate, to the present, when we split "tenths."

The Foreman's Job

Being a skilled mechanic is no longer an essential recommendation for promotion to foremanship. Unless it includes the ability to get along with others, and to urge them to better things, it may even be a handicap. For many skilled workers are intolerant of those who lack their ability. And the modern foreman's job is to get results with men of *average* intelligence and skill. Many bosses, and owners, who began as skilled mechanics, get peeved when they see a mechanic who is clumsy at his work. They forget that if all the men in the shop were as good as they were, the other fellow might be in the office and they out in the shop. Henry Ford is credited with saying that it is industry's job to utilize the kind of labor available in his community. This puts it up to the foreman to get the best work possible out of the workers supplied by the employment office.

Round Guides

Round surfaces for machine fits have been used with varying success for many years. One of the newer small millers uses two parallel bars to guide the movement of the milling head. Shell lathes were built during the last war with ground steel bars, for carriage ways and lathe bed. Grinding machines use round bars and sleeves to guide the grinding wheels. Who remembers the milling machine made in Hoboken, N. J. with a large round column which acted as a support and guide for the vertical movement of the knee? The maker was W. D. Forbes, a splendid mechanic who had an interesting shop by the waterfront and who afterwards moved it to New London.

Careful Balancing

If you want to get some idea of the importance of balance for high speed parts, watch them balance a large propeller for one of the big clipper planes. I saw one the other day at one of the Pan-American bases that was an eye-opener. It was a three-blade, adjustable pitch propeller, with each blade approximately 6 ft. long. The complete propeller was mounted on static ways and the balancer watched it with an eagle eye. It was almost perfect when I saw it, but he was putting on the finishing touches with a spray gun and lacquer. Just a whiff of lacquer across the end of the blade did the trick. And that is only an indication of the care taken in servicing all parts of these big ships.

Keeping Up Appearances

It's an old saying that appearances go a long ways. This seems to be especially true of the big transport planes, both as to mileage and the impression on passengers. One big airline polishes its huge metal planes by hand at a cost of 63 man-hours per polish. Believe it or not, they've done a lot of experimenting both with the kind of polish and the method of doing it. They've put the problem up to experts in polishing machinery—and

they are still doing it by hand. No combination of power driven rag wheel and polish gives the finish they get with proper cloths and elbow grease. They are still hoping to find a way of cutting down the cost of this polishing operation. But until they do they put 63 man hours on the planes to have them look just right.

Rigidity and Tool Life

All theories seem to get knocked into a cocked hat at times. The advantage of rigidity in cutting tools seemed to get a black eye some years ago when one disbeliever put a vibrator at work massaging the tool and claimed that it cut better. It's on record in *American Machinist* about ten years ago. But it would be hard to convince a certain boss in a frog and switch shop. He has two planers, similar in design except that one is heavier in every way, and has the tool and tool holder clamped against abutments like the famous rock of Gibraltar. Tool life between grinds has increased 50 per cent; and some of the chips are about 1/16x3 in.

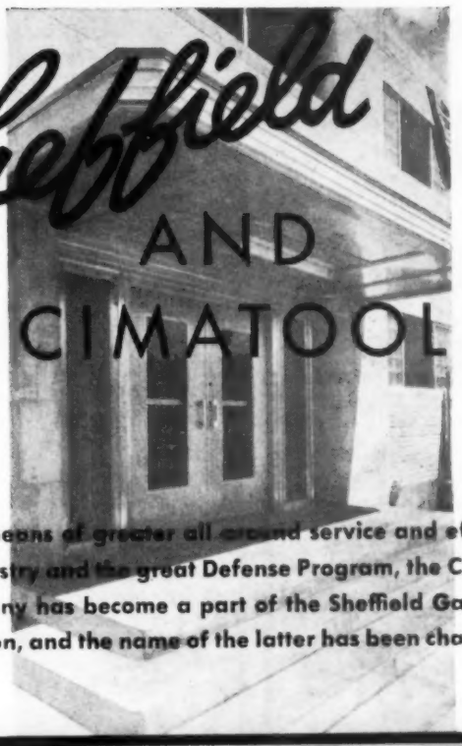
Gun Reaming Hasn't Changed

One of the jobs that does not seem to have changed materially for many years, is the reaming of guns, especially in the larger sizes. Boring tools have been improved by the use of newer cutting materials and in design, but reaming apparently follows the same practice as for the last quarter century, or longer. Reamers are still packed with wood, usually maple, between each pass of the reamer, as the chips play hob with the wood as the reamer goes through. And this wood has to be carefully selected and prepared, according to gun reaming experts, who are very scarce. Honing is said to have cut the finishing time somewhat, but it is still a tedious and time consuming job. The bore must be straight as well as round, so that deflection in the reamer bar and in the gun itself, must be considered. Some German plants are said to bore the guns vertically, which seems to have advantages.

Turning Stone Columns

Machining stone columns presents a lot of problems that would stump the average mechanic. And the solutions have changed appreciably in the last few years. The first radical change came with the use of grinding as a common machining operation. Charles Norton played his part in this, perhaps 30 years ago. The use of grinding in stone work has grown tremendously as a result, particularly as a method of finishing.

Changed too, are the methods of handling the work in lathe and in other machines. Support for stone columns in the lathe was formerly done with a 60 deg. center bearing in an iron plate fastened to the end of the



Sheffield AND THE CIMATOOL CO.

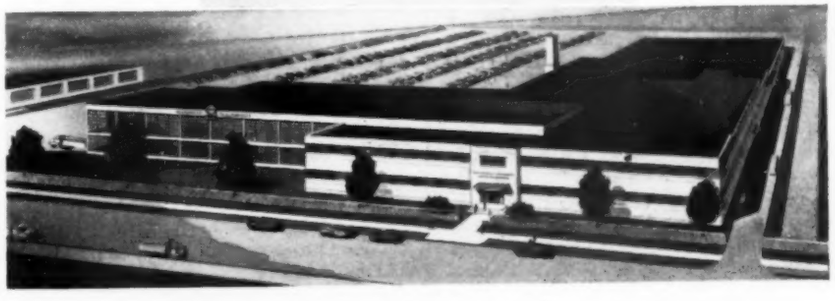
As a means of greater all around service and efficiency to industry and the great Defense Program, the Cimatool Company has become a part of the Sheffield Gage Corporation, and the name of the latter has been changed to

THE SHEFFIELD CORPORATION

with four principal divisions—the Gage Division, the Machine Tool Division, the Special Tool and Die Division and the Engineering Service Division.

With the new plant addition, more than two million dollars worth of production facilities are now combined in the greatest operations of the organization's history, operations that embrace precision gages, machine tools, dies, tooling, jigs and fixtures.

America's finest inland gage plant invites your inquiries on all precision products.



THE SHEFFIELD CORPORATION

Gage Division · DAYTON, OHIO, U.S.A.

SHEFFIELD MASTER GAGEMAKERS

When Tooling up for Munition Parts, save *TIME - MONEY* and *WORRY* by using these Proved Cutting Fluids *FROM THE START!*

TAKE advantage of the lessons that others have learned in solving the tough problems of achieving maximum production on munition parts work. STUART OILS together with STUART OIL Engineering Service will help set you up for top efficiency—*right from the start!*

STRAIGHT CUTTING OIL

Stuart's ThredKut

Widely used by Government manufacturing armories and arsenals and the aircraft and related industries. Highly recommended for tapping, threading, deep drilling, broaching, gear cutting, and for all machining of alloy steels.

WATER SOLUBLE CUTTING OIL

Stuart's SOLVOL

This new type of liquid cutting compound was developed because of the need for a "water coolant" capable of handling certain tapping, threading and very high speed turning operations on carbon steels that heretofore demanded straight cutting oil. Stuart's SOLVOL has a higher cutting quality and rust preventative value than ordinary soluble cutting oil. Try it on a few "borderline" jobs and see the difference.

WATER SOLUBLE GRINDING COMPOUND

Stuart's CODOL

This liquid grinding compound is known and widely used throughout the United States, Canada and Europe. It is highly regarded as an advanced development in grinding lubrication.

THREAD GRINDING OIL

Stuart's TK-99 or SK-81XR

Use Stuart's TK-99 on alloy steels, and Stuart's SK-81XR on high carbon steels. Get production speed up where it counts!

Write . . . wire . . . or phone today for trial drums of these Stuart Products. You'll get 100% satisfactory performance or 100% credit. That's our guarantee.

● Visit us in Booth C-1, National Metal Congress Philadelphia, Oct. 20-24.

For All Cutting Fluid Problems

D. A. STUART OIL CO.
LIMITED

Chicago, U.S.A. **Est. 1865**

Warehouses in All Principal Metal Working Centers

column. Now these end plates are much more mechanical and the weight of the columns is carried on roller bearings of curved outline to permit slight self-adjustment. And as with other lines of work, greater accuracy is demanded than ever before. Diameters, they tell me, are now held to a few thousandths.

Remind the Worker of Safeguards

Those of us who remember machines with open gears waiting to grab the whiskered machinist or the fellow with the tattered sleeve or loose necktie, may think that guards have eliminated all the danger from the shop. But though accidents have been greatly reduced there are still too many. Most of which can be traced to carelessness or even refusal to use goggles or other safeguards. One shop has plainly worded signs on all machines that are at all hazardous. A large hydraulic press, for example, carries a card that says in easily read letters "A GUARD HAS BEEN PROVIDED FOR THIS MACHINE" and tells how it should be used.

We Like to be Shown

Not long ago I mentioned the practice of one machine tool building concern which found it advisable to make demonstration drawings of their machines in color. These drawings show exactly how the machine handles the particular job. While one of the marks of a good mechanic is to be able to adapt ideas to his own use, many need to be shown the exact application to their own work. Other concerns are finding the free use of illustrations of work done on their machines observable in their publicity. When the work is shown, with data as to the size, material and time taken, it is easy to see where money can be saved on similar work in our own shops.

Machine Tool Ways

By JOHN R. GODFREY

Bearing surfaces on machine tools are far from being standardized, which may not be altogether a disadvantage. We still have cast iron carriages which run on cast iron ways. Then we have cast iron carriages running on flame hardened ways and on hardened steel ways, with a few machines having hardened strips on the carriage as well as the bed.

Some of the hardened steel ways are finish ground in place on the bed but more seem to be finished before putting into place. When this is done the bed, or seat, for the hardened way must be carefully ground, or scraped, or both, to be sure not to spring the way in fastening it down. This difficulty might be overcome by grinding the ways in place but this introduces another possibility of error. When a piece is held down solidly at a few points it has been found that the dissipation of heat is not uniform and that they may not be flat after cooling down.

Fastening the hardened strips is done in several ways. The most common method is to use fillister head screws from the top. Some, however, use them underneath so as to have no opening on top and at least one builder puts studs in the under side of the hardened ways.

After the hardened ways are in place it is common practice to lap them in using a mild abrasive. Valve grinding compound is a favorite in some shops. Some of these compounds use an abrasive that breaks down, or loses its cutting edge, in a very short time. In this respect it resembles the old household scouring soap, known as Sapolio. This has been used in various shops for "nigh on 40 years." I first saw it in the old Acme automobile shop in Reading, Pa., about 1908. I also found it used in machine tool spindle bearings only a couple of years ago.

Machining beds of machine tools is another practice that varies from year to year. Milling and planing take turns as favorite methods. Advocates of single cutting of course favor the planer. Some who went to milling, have found it advantageous to use a special planer for finishing, largely on account of a decrease in the time necessary for scraping. This too is a disputed point and of course depends largely on the way in which the milling is done.

Distortion, due to the weight of tools and work, has to be reckoned with, has to be carefully considered where accuracy is important. An extreme example of this is the case of a large turret lathe in which the turret and its tooling weighs about 4000 pounds. This weigt of course distorts the lathe bed to some extent, no matter how careful its design. To counteract this the makers put a weight of 3500 pounds on top of the turret while the turret holes are being bored. In this way the bed of the machine is deflected to the same extent as when loaded with the regular tooling.

Bell mouthing is one of the headaches that come in many reaming jobs. In one recent case this was sufficient to cause the resort to boring to finish size in an ordinary engine lathe. Of course diamond point boring is one of the answers to this difficulty, and it has been adopted for high precision work. But reaming can still be used on many jobs if the bell mouthing can be eliminated.

In the case just mentioned the difficulty was eliminated by the simple expedient of putting a close fitting pilot on the front end of the hand reamer used in the finishing operation. This, in connection with a floating holder for the reamer will take care of considerable mis-alignment between tail and head spindles, in machine as well as hand reaming.